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Nesting Habits of the Western Painted Turtle, *Chrysemys picta bellii* (Gray)

By JOHN M. LEGLER

Nesting habits of the painted turtle were studied in the spring and summer of 1953 at Sand Lake, which is immediately northeast of Norseland and approximately 12 miles northwest of St. Peter, Nicollet County, Minnesota. Turtles were obtained from the water by the use of dip nets and basking traps and were picked up by hand along roads and near nesting sites. Eggs were taken from the oviducts of captured females and from nests. Most females with oviducal eggs were captured on land, in the evening. Nests were located by their characteristic caps of hard earth.

One small part of the Sand Lake area was thoroughly searched for nests at frequent intervals. Most data on nesting were obtained from this one part, which was about 20 yards square, although many nests were observed in other parts of the Sand Lake area. When a nest was discovered, it was marked with a small, numbered, wooden stake.

Eggs that were removed from the nests were protected from direct sunlight and placed inside a wooden box which contained a damp towel. Eggs were artificially incubated in clay. The soil was placed in large flower pots or wooden boxes and made to resemble as nearly as possible the original nest. During the entire period of incubation, the open pots and boxes were exposed to the weather on the western edge of the porch roof of the writer's two-story house. Each egg in each clutch was numbered with a hard pencil.

The genital organs and digestive tracts of turtles brought to the laboratory were removed and preserved. Measurements and weights were recorded for every turtle obtained. Unless otherwise stated, all measurements given in this paper are in millimeters and weights are in grams.

SEXUAL AND AGE DIFFERENCES

Agassiz (1857: 491) stated that females of *Chrysemys picta* begin laying at the age of 11 years. Cunningham (1923: 57), discussing intergrades between *C. picta bellii* and *C. picta marginata*, stated that mature females have a carapace at least 130 mm. long and that males are mature when the carapace is 88 mm. long. I considered 33 females obtained from Sand Lake to be sexually mature; the length of the plastron ranged from 123 to 182 mm. In 12 males that were considered to be sexually mature on the basis of secondary sexual characters (elongate

claws on fore feet and increased preanal length), the length of the plastron ranged from 83 to 144 mm.

The average measurements of the turtles mentioned immediately above are as follows: length of carapace, ♀ 168±7.65 (131-196), ♂ 122±22.67 (95-160); width of carapace, ♀ 126±4.93 (104-144), ♂ 93±12.49 (75-115); length of plastron, ♀ 160±7.1 (123-182), ♂ 112±20.57 (83-144); width of plastron, ♀ 103±4.6 (86-116), ♂ 75±10.54 (58-92); height of shell, ♀ 60±3.78 (44-68), ♂ 41±6.32 (33-54); length of tail, ♀ 63±4.12 (51-79), ♂ 56±8.94 (44-72); and weight, ♀ 600±73.3 (297-844), ♂ 229±115 (101-482). The sex ratio for adults was approximately 1:2.7. Forbes (1940: 132) has indicated that most reptiles deviate from a 1:1 ratio. Concerning turtles in general, Carr (1952: 9) stated: "In many species, at least, females outnumber the males." Actually, true sex ratio in adults is obscured by differences in habits and behavior that result in biased collecting.

Cagle (1944: 150), on examination of undeveloped eggs in the ovaries of females of *Pseudemys scripta elegans*, concluded that females containing ovarian eggs which are slightly smaller than the yolks of average oviducal eggs, are capable, potentially, of laying eggs in the following season. Such females were considered by Cagle to be sexually mature. He reported that senile ovaries were found in some of the older females which he examined. Cagle (1948: 109) found that males of *Pseudemys scripta troostii* in which the plastron was 90 to 100 mm. long usually were mature with secondary sexual characteristics developed. Cagle stated (1950: 44): "The attainment of maturity is primarily dependent on size, not age."

These conclusions would seem applicable also to the closely related genus, *Chrysemys*. My only positive method of determining sexual maturity in females was to find them laying eggs or to find developed eggs in their oviducts. The secondary sexual characteristics of males do not seem to be noticeably developed until sexual maturity has been reached.

In *C. p. bellii*, the most noticeable sexual difference is in size and weight. Van Denburgh (1922: 984) lists measurements of a specimen with a plastron 232 mm. long without mentioning its sex. Pope (1939: 182) states that Surface found females of *C. p. picta* to be relatively higher and broader than males. My own data on 33 females and 12 males show the following average secondary sexual differences: height of shell contained in length of tail, ♀ 1.05, ♂ 1.36; width of carapace contained in length of carapace, ♀ 1.32, ♂ 1.31; width of plastron contained in length of plastron, ♀ 1.55, ♂ 1.49; height of shell contained in length of carapace, ♀ 2.80, ♂ 2.97; height of shell contained in length of plastron, ♀ 2.67, ♂ 2.73. It will be noted that the length of the tail in females approximates the height of the shell, whereas in males, the length of the tail exceeds the height of the shell by approximately one-third.

Concerning *C. p. marginata*, Grant (1936: 331) wrote that, "As is usually the case, the male is very nervous, active, and vicious. They wave all four feet when picked up instead of retracting, as is the custom of the females." He indicated also that the male of this subspecies might be

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more intelligent than the female. I noted no sexual difference in temperament in the turtles that I handled.

PRODUCTIVITY AND MORTALITY

Concerning turtles in general, Carr (1952: 13) states that, "There is some correlation between the size of the species and the size of the clutch, and considerable correlation between the size of the individual and that of the egg complement. A large mature turtle may lay as many as twice the number of eggs deposited by a newly-matured and smaller individual." Cahn (1937: 168) was of the opinion that small egg-clutches of *Pseudemys* might have been laid by young females. Cagle (1950: 38) found a correlation (r=70) between the number of eggs in a clutch and the length of plastron of the female in *Pseudemys scripta troostii.*

For *C. p. bellii*, Breckenridge (1944: 182) reported four to ten eggs per clutch in Minnesota; Carl (1944: 46) found six to 20 per clutch in British Columbia; Blanchard (1923: 24) reported that ten clutches examined by him in Iowa contained 13, 12, 12, 11, 9, 7, 7, 6, 6, and 5 eggs (average, 8.8). In the Sand Lake area, 13 clutches had 11, 11, 11, 11, 11, 10, 9, 8, 7, 7, 7, 6, and 5 eggs (average, 8.8). The following are the plastral lengths of five turtles and the number of eggs each deposited: 171 mm., 10 eggs; 168 mm., 7 eggs; 160 mm., 11 eggs; 155 mm., 7 eggs; and 150 mm., 8 eggs.

In Minnesota, *C. p. bellii* probably lays only one clutch of eggs per year. There would seem to be insufficient time for eggs of a second clutch to be deposited and for incubation to start before the advent of cold weather in the autumn. Cagle (1950: 38) indicates that more than one clutch of eggs per year might be possible for *Pseudemys scripta troostii.*

Agassiz (1857: 489-490) stated that ovarian eggs fell into as many as four distinct size categories in many *C. picta.* The largest ovarian eggs were almost as large as the oviducal eggs which were about to be laid. Concerning the ovarian eggs, he wrote, "These eggs appear in well-marked sets of different sizes, each set being equal in number to the average number of eggs laid by the species under observation." Ovarian eggs dissected from four females from Sand Lake were in poorly defined size groups. Two females still retained oviducal eggs and one other female was found at the nest with her freshly laid clutch. In these three individuals I found that the female with the largest ovarian eggs had produced the largest mature eggs. It seemed likely that the future fecundity of an individual female could be determined by counting the number of ovarian eggs.

The rate of casualty of the eggs in the nests is high, but seemingly varies according to the location of the nest. Of 25 nests, in the area approximately 20 yards square that was most thoroughly examined, at lease five were robbed by predators. This area was a firing range used by the Boy Scouts of America of Camp Norseland and was considerably farther inland than the other observed nesting sites. One Boy Scout camper reported the tracks of a raccoon around one of the robbed nests. The rate of casualty in other parts of the Sand Lake area was even higher and most of the nests were robbed before I had a chance to examine the

eggs. More nests that were close to water were robbed than those farther inland. The nest predators were not positively identified. Skunks, gray squirrels, foxes, badgers, raccoons, and men all have been reported in the literature as robbing turtle nests.

The odoriferous fluid voided by the nesting female may lead to the early discovery and destruction of the eggs by predators. Most predation on nests occurred within a day or two after the eggs were laid, and often within a few hours. Most nests that survived until the first heavy rain were never robbed. Heavy rain dissipates any odors about the nest and erodes the nest plug, making the nest more difficult for predators to detect. I often had trouble finding unmarked nests after a rain. Nests were robbed chiefly at night. Ants and various unidentified insects were found on the eggs in some of the nests. On one occasion, when I was rowing a boat near shore, a garter snake, *Thamnophis radix*, was seen swimming in the water with an egg in its mouth. When one of my companions attempted to capture the snake, it dropped the egg, which could not be recovered. The size and shape, however, caused me to believe that it was an egg of *C. p. bellii*.

Crows, bullfrogs, and large fish have been known to prey upon hatchling turtles, and larger turtles probably do. In April of 1953, after the ice had receded from shore, I found many dead *C. p. bellii* of various sizes and in various stages of decay, which had evidently succumbed in winter. Gnawed carapaces were found near a muskrat burrow.

Eggs which were dented by handling or by some other mechanical means usually regained their normal shapes after several days, unless they were dehydrated or spoiled. Eggs which were closest to the nest opening were more often dented and dehydrated than eggs closer to the bottom of the nest cavity. Often, when several decaying eggs were in a nest, mildew surrounded them and other eggs nearby. After heavy rains, nests that were in clay soil were observed to have water standing in them, but its effect on the eggs is unknown.

EGGS AND NESTS

Carr (1952:222) states that, in general, nesting of *C. p. bellii* begins around the latter part of May over most of its range but may occur as early as the first of May in British Columbia. Smith (1950:147) reports June and early July as the nesting months. For *C. p. marginata*, Pope (1939:192) reports that nesting occurs mostly in June and the first three weeks in July. Nesting at Sand Lake was observed as early as June 16 and as late as July 14. Interested persons reported nesting as early as June 1 and as late as July 28.

Smith (1950:147) states that the eggs of *C. p. bellii* "are white and measure 28 to 32 mm. long and 17 to 20 mm. thick." The average size of 41 eggs (7 clutches) measured by Cahn (1937:144) was 34.7 x 17.8 mm. Breckenridge (1944:182) reported eggs ranging from 30 to 33.5 mm. in length and from 18 to 20 mm. in diameter. Carr (1952:222) gives the average size of the egg as approximately 34.5 x 17.8 mm. For 70 eggs from the Sand Lake area, the length averaged 29.9 mm. $\pm$ 1.16 (25-34) and for 66 of these eggs the width averaged 19.0 mm. $\pm$ .67 (16.9-22.8). Four eggs were grossly dented, preventing accurate measurement of width.

My data indicate that the normal shape of the egg approximates that of an ellipse. Smith, Cahn, and Carr, however, indicate that a more elongate egg is usual. Egg shape in clutches examined by me varied individually and by clutch, but with no set pattern. Eggs removed from the oviducts were not significantly different in shape from those in nests.

The average weight of 17 eggs from the oviducts of two females was 6.19 grams (4.93-7.50). All the eggs examined were pure white at the time of discovery and had smooth, unpitted shells. Eggs removed from oviducts were slightly translucent and had a pinkish tint. When allowed to dry for a few minutes, the shells became white.

Cagle (1950:38) wrote that, "With the progress of incubation [in *Pseudemys scripta troostii*] the eggs increase in size, often to the extent that they are crowded tightly in the nest cavity and molded into odd shapes." He measured 122 eggs in June 1947 and 97 eggs in July 1946 and found their average size to be 39.1 x 21.9 mm. and 36.9 x 22.6 mm. respectively.

Seven eggs were dissected from the oviducts of a Sand Lake female and measured on July 4. They were measured again on July 16 and again on August 3. Over the 30 day period there was a mean increase in diameter of 2.25 mm. (1.3-3.2) and a mean decrease in length of .575 mm. (0.2-0.9).

On June 16 a turtle, discovered on the firing range at 6:45 P.M., had finished digging her nest-cavity. A quantity of earth had been piled up in back of her with the moister earth, more recently excavated, farthest from the opening of the cavity. The turtle began to lay eggs soon after she was found. Intervals between eggs of 65, 90, 30, 10, and 25 seconds (mean, 44) were recorded intermittently in the period of laying. At 7:15 P.M., after the turtle had laid 11 eggs and had started to pull some of the earth back into the nest-cavity, I removed her and examined the nest. The turtle took no notice of me until she was actually handled. I covered and marked the nest but it was robbed that same evening by a predator. Stromsten (1923) described in detail the nesting of an individual *C. p. bellii.*

At the nesting site, the turtle usually does some preliminary scratching of the top soil with the hind feet. The earth is then moistened with fluid from the bladders. The digging of the nest cavity proper is accomplished by the hind legs working alternately with semicircular strokes loosening earth from the inside. The earth is lifted from the cavity on the under surface of the hind foot with a series of shovellike movements. The wettest earth, which is removed first, is farthest to the rear of the turtle and is the last to be replaced. During oviposition, the hind leg is inserted intermittently into the cavity, seemingly to arrange the eggs. Occasionally some earth is moved into the cavity before all of the eggs are laid. When laying is completed, the turtle reaches back with the hind feet and pulls the earth into the nest-cavity. The resulting mound of earth is seemingly compacted by the feet and the plastron. Several females found at nesting sites had wet mud on their plastrons. The footprints of turtles were observed on fresh nest plugs. Turtles returned to the nearest water as soon as their nests were completed.

Pope (1939: 192) reports that digging usually starts between 4:00

and 6:30 P.M., but mentions one instance of a nest completed at 4:00 P.M. and another begun at 8:17 P.M. Smith (1950: 147) states that nesting usually occurs in late afternoon or evening and that the process takes as long as two hours.

Painted turtles in the Sand Lake area nested chiefly between 5:00 and 6:00 P.M. None was observed nesting in the early morning. All the nests found by me were exposed to direct sunlight for most of the day, but excavation of the nest and oviposition occurred chiefly when the nesting area was shaded or the light was considerably reduced. No turtles were seen laying during heavy rains. Several writers have indicated that either eastern or southern exposures are the usual nesting sites. Carl (1944: 45) reports that in British Columbia the nesting site is consistently on a slope with a southern exposure. The small part of the Sand Lake area, on which most of the nests were found, was nearly flat. The most nearly unbroken horizon was toward the east, as trees bordered the other three sides.

The nests are flask-shaped cavities, plugged with caps of hard earth. Six nests had the following average dimensions: greatest diameter of cavity, 83 mm. (70-120); diameter of opening, 57 mm. (50-65); depth, 80 mm. (70-90). The nests were chiefly in clay soil. Moisture content of the soil and the amount of fluid voided on it by the turtle affect the ease of nest construction and possibly the size of the nest. Hard objects in the soil such as roots and stones prevent the turtle from excavating a cavity of typical shape, or may even cause the turtle to abandon digging operations completely and move to a new location. One nest, which contained normal eggs, had a stone approximately one half inch in diameter protruding from the bottom.

Depth of the nest is determined by the length of the female's hind leg. Several nests seemed too small for the number of eggs they contained, as the uppermost eggs were flush with the surface of the surrounding soil or even higher. As a result, the eggs were partly crushed or dented when the turtle compacted the nest plug. In one instance, when I removed a nest plug, an egg came away with it. Evidently the plug had been compacted around the egg rather than over it. Such deviations from the typical pattern of nest building seem to lessen the eggs' chances of survival.

Turtles selected an area of clay soil for nesting in preference to black loam soil nearby. They were never observed to dig through sod when bare earth was readily available as in the middle of a cowpath, a road, or an eroded place. Eggs kept in artificial nests of sand and black loam tended to dehydrate more than eggs kept in clay. Nests were usually found in open areas and never under a canopy of vegetation, nor in forested areas.

Nests were found at varying distances from the nearest water. In 16 instances, nests were 52, 49, 48, 46, 44, 44, 44, 43, 43, 41, 39, 33, 26, 26, 25, and 23 yards from the nearest water. Nests in other areas were as close to the water as one yard, and one marked turtle traveled 250 yards from water to nest. Two turtles which contained fully developed oviducal eggs, were captured on different dates (June 24 and July 3) crossing a road more than 500 yards from the nearest water. Presumably, they were in search of nesting sites.

Many trial holes were discovered and, in several instances, I saw the turtles making them. Abandonment probably results from unsuitable soil conditions. Two nests were found which had been completed and capped, but in which there were no eggs.

Carr (1952: 13) is of the opinion that fluid voided from the bladder facilitates nest excavation merely by softening the soil. Cunningham (1923: 70) found that fluid from the accessory bladders was used for moistening the soil when the turtle was digging the nest and that the fluid contained therein was "excretory in nature." Fluid from the bladder may aid in maintaining a high humidity within the nest during the early stages of incubation.

Records in the literature of the incubation period for *C. picta* include: approximately 72 days (Smith, 1950: 147); 74 days (Pope, 1939: 197); 75.5 days (Finneran, 1948: 126, average for four clutches). Cunningham (1939: 383) incubated the eggs of *Malaclemys centrata* Latreille in separate groups at 85 degrees F. and at room temperature (65 to 92 degrees F.) and found that both groups hatched in 61 to 68 days. Eggs maintained at 95 degrees F. did not survive; development was temporarily stopped in eggs kept at 55 degrees F.

The only incubation record for *C. p. bellii* in Minnesota seems to be that of Breckenridge (1944: 182). He reports incubation periods of 92, 98, and 104 days based on the discovery of young turtles in the nests (but actual time of hatching was not stated).

An artificially incubated turtle egg from Sand Lake began hatching on the 69th day, and the turtle was not completely free of the egg shell until six days later. Its carapace was 22.2 mm. long; the yolk sac was 8.5 mm. in diameter. This was the only egg that hatched of 98 eggs artificially incubated. Embryos were taken from eggs at various stages of development and preserved. Movements of the young turtles within several of the eggs could be detected 72 days after the eggs were laid. The outer calcareous layer crumbled off one end of the shell as a result of these movements and only a thin, translucent membrane separated the turtle from the outside. Movements occurred at average intervals of 39 seconds and continued for slightly more than one day. Two days after these movements ceased, I removed the young from the eggs and found them to be dead.

Breckenridge (1944: 182) suggests that overwintering of embryos inside the eggs in Minnesota, or of hatchlings overwintering inside the nests, may be a normal occurrence and Carl (1944: 46) states that such overwintering is usual in Canada. I suspect that, in southern Minnesota, eggs laid early in the nesting season hatch in time for the young to emerge in the autumn, whereas those eggs laid later in the season may remain in the nest until the following spring. A newly emerged hatchling turtle with a well-healed navel scar was captured on April 26, 1953, at Sand Lake, 21 days after all of the ice had disappeared. The temperatures of the air and water were 11.5 and 9.0 degrees C. respectively.

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Notes on the Distribution of Some Reptiles in Western Mexico

By RICHARD G. ZWEIFEL

The present report deals with lizards and snakes from western Mexico contained in the collection of the Museum of Vertebrate Zoology. Some of the records result from a trip taken by William J. Riemer and the author through Chihuahua, Durango, Sinaloa and Sonora during the summer of 1953, while other records are based on specimens taken by Museum staff members or private individuals on previous trips. Catalog numbers cited following locality records refer to specimens in the Museum of Vertebrate Zoology. I wish to thank Dr. Robert C. Stebbins for helpful criticism of the manuscript. Funds which made the trip by Mr. Riemer and the author possible were furnished through The Annie M. Alexander Memorial Fund, kindness of Mrs. Martha Alexander Gerbode, and through the Revolving Research Fund of the American Society of Ichthyologists and Herpetologists.

Sceloporus bulleri Boulenger

El Batel, 5100′, Sinaloa (44694-9)

El Batel is on the Durango-Mazatlán road, about 33 miles east and 15 miles north of Mazatlán. These lizards were collected by Dr. A. S. Leopold and W. C. Russell on October 16-21, 1946. They constitute a new state record and an extension of the known range about 200 miles to the north-northwest of the nearest previously reported locality in Jalisco. According to the field notes of the collectors, the lizards were found both on fallen logs and on the trunks of living pine trees.

Sceloporus jarrovi jarrovi Cope

16 mi. (by road SW La Ciudad, 7800′, Durango (in Sinaloa?) (59090); 17 mi. (by road) NE (59091) and 10 mi. (by road) NE El Batel, 6400′, Sinaloa (59092-4).

These localities are on the Durango-Mazatlán road. Though the species has not previously been reported from Sinaloa, it has been known from adjacent parts of Durango and Chihuahua, and probably occupies the highlands along much of the eastern border of Sinaloa. For comment regarding the locality for number 59090, see the account of *Crotalus lepidus*.

Eumeces brevilineatus Cope

5 mi. W Piedra Blanca, 5000′, Sierra del Carmen, Coahuila (58388); 8 mi. SW Piedra Blanca, 7000′, Sierra del Carmen, Coahuila (58377).

Although previously unrecorded from Coahuila, this species was to be expected there in view of its presence in the adjacent Big Bend region of Texas. The lizards were obtained by Dr. Alden H. Miller on April 13 and 28, 1953. They were found in canyon bottoms, one in oak-pine forest where oak predominated and the other in oak-madrone forest with no pines present. In each instance, there was a thick ground cover of dry oak leaves.

Eumeces brevirostris (Günther)

7 mi. SW Lagunita, 7800′, Chihuahua (59138); 3 mi. N Río Verde, 7600′, Chihuahua (59139); 6 mi. WSW Las Adjuntas, 8500′, Durango (59140-52).

In his monograph of the genus *Eumeces,* Taylor (1935:463-4) mentions certain variations in scalation seen in this species. In four specimens from Durango and Jalisco, the interparietal is enclosed by the parietals, and in one of these specimens the primary temporal is fused to the upper secondary temporal. Lizards from the southern part of the range (Oaxaca, Veracruz) commonly have a distinct primary temporal and an unenclosed interparietal. All 15 of the Durango and Chihuahua lizards in the MVZ collection have the interparietal enclosed, eleven have the primary and upper secondary temporals fused on both sides, and two have them fused on one side only. Thus out of 15 specimens, only two have the scalation "typical" for *brevirostris.* The enclosed interparietal results in a considerable resemblance to *Eumeces indubitus,* but that species regularly has a distinct primary temporal. Also the color pattern of the MVZ specimens is more like typical *E. brevirostris.*

It is possible that the northern population should be recognized as a race distinct from typical (southern) *brevirostris.* Taylor *(loc. cit.)* has suggested that with accumulation of sufficient material, subspecies or even species might be recognized within the present *E. brevirostris.*

The Durango specimens were found beneath logs and rocks, or sunning close to such shelter, on July 9, 1953. The Chihuahua lizards, taken on June 30 and July 3, are recently born young. The species has not previously been reported north of the El Salto region of Durango, so the Chihuahua specimens, taken at the extreme southern edge of the state, constitute a new state record and a northward range extension of 200 miles.

Gerrhonotus kingi kingi (Gray)

Sierra de Ixtlán near San Marcos, Jalisco (56316).

San Marcos is about 50 miles west and 10 miles north of Guadalajara. The lizard was obtained from a Mexican by Dr. John Hendrickson. Previously, the southernmost locality for the species was in west-central Chihuahua. The range extension is about 550 miles. This species is likely present throughout the Sierra Madre Occidental, though not yet recorded from Sinaloa and Durango.

Leptotyphlops humilis segregus Klauber

3 mi. NW Chihuahua, Chihuahua (57331).

Obtained by S. Weitzman on August 19, 1952, this specimen represents the first of its subspecies to be recorded from Chihuahua. A record for this species from Batopilas in the Sierra Madre Occidental probably refers to *L. h. dugesi* (Smith and Taylor, 1945:22).

Coluber constrictor stejnegerianus (Cope)

8 mi. SW Piedra Blanca, 7000′, Sierra del Carmen, Coahuila (58362).

Northern Coahuila is included within the general statement of range given for this subspecies by Schmidt (1953:188), but there appear to be no specific localities published. The snake was found by Dr. A. S. Leopold in an open forest of yellow pine on April 4, 1953.

Masticophis taeniatus ornatus Baird and Girard

1.3 mi. N Pachera, 6500′, Chihuahua (59286).

The presence of this race at the western edge of the plateau tends to verify Smith's (1941: 391-2) belief that *M. t. taeniatus* does not range

south in the central plateau region. *M. t. ornatus* is now known from western Chihuahua and western Coahuila. The Pachera specimen was found on June 26, 1953, in a region where piñon and scrub oak were dominant. There have previously been no specific locality records for this race in Chihuahua.

Salvadora hexalepis deserticola Schmidt

9 mi. N Mazatlán, 100′, Sinaloa (59287).

This individual is an adult male with 185 ventral scales. The ventral count is typical of *deserticola* and may be considered as further evidence in favor of the proposal of Bogert and Oliver (1945: 366) to refer *S. hexalepis celeris* Smith 1941 to synonomy. The latter race was based on specimens from northern Sinaloa with slightly higher ventral counts than *deserticola*. The record for Mazatlan constitutes an extension of range of 250 miles to the south of the previously recorded southernmost locality, San Blas, Sinaloa. The snake was found active at mid-day on the ground in dense thorn forest.

Lampropeltis getulus splendida (Baird and Girard)

1.4 mi. N. Morcillo, 6300′, Durango (59294).

The recent report of this race in San Luis Potosí (Taylor 1952: 811) and the present specimen are indicative of an extensive range throughout the Chihuahuan Desert. As is common for this race, this specimen was found on the road at night during a lull between showers. The species has not previously been reported from Durango.

Pituophis catenifer affinis Hallowell

13 mi. N Mazatlán, Sinaloa (59290); 17 mi. N. Mazatlán, Sinaloa (59289); Resolana, 6300′, 18 mi. NW La Zarca, Durango (56973); Río Nazas at San Salvador, Durango (59292).

Along the Pacific Coast, *P. c. affinis* has been recorded only as far south as Ahome in northern Sinaloa. The specimens from near Mazatlán, which were found on a thorn forest-bordered road on the night of July 16, 1953, constitute a southerly range extension of about 240 miles. They resemble *P. c. vertebralis* of the Cape region of Baja California in possessing a black stripe along the subcaudal surface. The Durango specimens represent the first records for the state.

Pituophis deppei deppei (Duméril)

Zacatecas, 8000′, Zacatecas (56974).

A young individual obtained by Dr. Alden H. Miller on June 28, 1952, marks the first record for the state, though the species is known from the surrounding states.

Hypsiglena torquata jani (Dugès)

16 mi. N Durango, Durango (59299).

This snake was found alive on the main highway on the evening of July 6, 1953. This race has been reported no closer to the present locality than San Luis Potosí, 275 miles to the southeast.

Crotalus lepidus klauberi Gloyd

16 mi. (by road) SW La Ciudad, Durango (In Sinaloa?) (59310).

Due to inadequate maps and a consequent uncertainty as to the location of the Durango-Mazatlán road with respect to the state boundary,

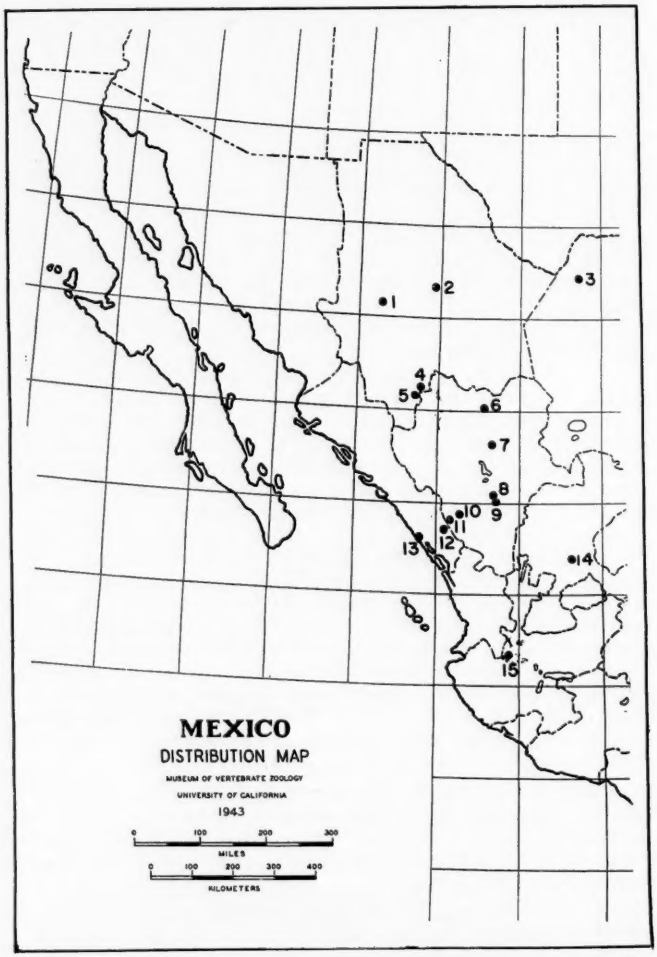

FIGURE 1.—Map of localities mentioned in text: 1, Pachera, Chihuahua; 2, Chihuahua, Chihuahua; 3, Piedra Blanca, Coahuila; 4, Lagunita, Chihuahua; 5, Río Verde, Chihuahua; 6, Resolana, Durango; 7, San Salvador, Durango; 8, Morcillo, Durango; 9, Durango, Durango; 10, Las Adjuntas, Durango; 11, La Ciudad, Durango; 12, El Batel, Sinaloa; 13, Mazatlán, Sinaloa; 14, Zacatecas, Zacatecas; 15, San Marcos, Jalisco.

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it is not at present definitely established whether the specimen recorded above was taken in Durango or in Sinaloa, though the former seems more likely. However, DOR's too badly crushed to be saved were seen seven and nine miles by road northeast of El Batel, Sinaloa, establishing the presence of this species in Sinaloa.

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MUSEUM OF VERTEBRATE ZOOLOGY, UNIVERSITY OF CALIFORNIA, BERKELEY.

An Annotated List of the Amphibians and Reptiles of Union County, Oregon

By DENZEL E. FERGUSON

Union County, occupying an area of 2,032 square miles in the Blue Mountains of Northeastern Oregon, has been largely neglected by herpetologists, due probably to its rather isolated location. This neglect is indicated by the fact that of the 15 species to be treated, 10 of them are here recorded for the first time from the county.

The most conspicuous feature of the county is its diversity in regard to topography, climate, and vegetation. Elevation ranges from approximately 1,800 feet to nearly 9,700 feet, which enabled Bailey (1936) to include the Transition, Canadian, Hudsonian and Arctic-alpine life zones within the county's boundaries, with Transition and Canadian being most extensive. The area consists primarily of Tertiary lavas with lesser amounts of older granites and metamorphosed sedimentaries exposed. Nearly all of the county lies in the valley of the Grande Ronde River, most of which is given over to agriculture, although portions in the south are in the Powder River drainage system.

The annual rainfall ranges from about 12 inches to over 40, with the most coming in January and the least in July. Much of the precipitation comes as snow, some of which remains in patches the year 'round at higher elevations in the Wallowa and Elkhorn Mountains. Thunder storms are quite frequent during the summer months.

The vegetation is principally montane (*Pinus-Pseudotsuga*) and subalpine (*Picea-Abies*) forests. However, southern exposures and drier portions, generally being unforested, are largely given over to cheat (*Bromus tectorum*) and sage (*Artemisia tridentata*).

The present account concerns collections made at various times between August, 1953, and June, 1954. The specimens upon which this paper is based are to be deposited in the Oregon State College collection.

SPECIES ACCOUNTS

Ambystoma macrodactylum Baird

The long-toed salamander has previously been recorded from near La Grande by Gordon (1939). Collecting has shown it to be widely dispersed and common in Union County (Perry, Island City, La Grande, Thief Valley Reservoir, Grande Ronde Valley). On April 6, 1954, eggs and gravid females were collected at La Grande. The species was particularly easy to obtain in April when as many as six were found under one board near a breeding pond.

Ascaphus truei montanus Mittleman and Myers*

This species was collected from two localities on North Catherine Creek and one on West Eagle Creek. It seems likely that the Rocky Mountain tailed frog is as widely dispersed in the southern Wallowa Mountains as it was found to be in the northern parts of the range (Ferguson, 1952). Further collecting will no doubt reveal *Ascaphus* in Baker County as well.

On October 18, 1953, seven larvae ranging in length from 27-42 mm. were collected during a heavy snow storm which completely blanketed the hills less than 1,000 feet above. On May 2, 1954, adults were found in North Catherine Creek at 5,000 feet elevation, at which time water splashing from the rushing mountain stream was observed to form icicles upon overhanging vegetation. These two incidents would seem to illustrate the hardiness of *Ascaphus*.

Bufo boreas boreas Baird and Girard*

This toad was collected from near Thief Valley Reservoir and at Hot Lake. It is probably more abundant than these two records would seem to indicate. Recently deposited eggs of *B. boreas* were found in a roadside pool on April 22, 1954, at an elevation of about 3,500 feet.

Hyla regilla Baird and Girard

The tree frog was recorded by Gordon from Island City. It is probably the most widely ranging amphibian in the county (Perry, La Grande,

*Denotes new county record.

Hot Lake, Telocaset, Thief Valley Reservoir, Medical Springs, North Fork of Catherine Creek).

Hyla was heard in choruses at La Grande after warm rains on April 5, 1954. On May 2, 1954, adults were collected and recently deposited eggs observed at 5,000 feet elevation on North Catherine Creek.

Rana catesbeiana Shaw*

The bullfrog

The bullfrog was collected from six localities, all within the Grande Ronde Valley. It does not appear to occur in the foothill areas outside of the valley proper.

The bullfrog, probably first introduced into the county in 1917, is now extremely abundant in marshes and sloughs over most of the Grande Ronde Valley, and collecting seems to indicate that it has replaced the Great Basin spotted frog over much of this area.

On April 3, 1954, a large bullfrog was found which seemed to be still in partial hibernation, showing no evidence of activity. Near this spot, in the warm waters of Hot Lake, the species was found to be very active.

Rana pretiosa luteiventris Thompson

The Great Basin spotted frog

This species has been previously reported from Union County by Gordon (Island City, Grande Ronde River). In addition, I have found it at La Grande, Hot Lake, Medical Springs and Elgin.

Chrysemys picta belli Gray*

The western painted turtle

One specimen was taken near Hot Lake while seining for fish in a ditch supplied by warm spring water. The following day, one of my students reported seeing another in this same place. The species is apparently very rare in Union County to the extent that one might suspect it as being an introduction rather than a native form, even though it is well within the range of the species. The fact that the two above records are from warm springs would seem to lend some support to this view.

Sceloporus occidentalis longipes Baird*

The western blue-bellied lizard

This lizard was recorded from four localities in Union County, all of which were in the vicinity of Medical Springs. It undoubtedly occurs in the lower Grande Ronde area also, as it was found near Minam in Wallowa County by Ferguson (1952).

Eumeces skiltonianus Baird and Girard*

The western skink

E. skiltonianus was found to be quite abundant in the drier parts of the county, with over a dozen having been found in three areas (Thief Valley Reservoir, Perry, near Elgin). Several kept in the laboratory were found to be easily cared for, as they accepted moths and other insects quite readily.

Charina bottae utahensis Van Denburgh

The Rocky Mountain rubber boa

This snake was recorded by Gordon from near Elgin. Only a single specimen, found about three miles south of Elgin, was taken for the present study.

Thamnophis elegans vagrans Baird and Girard*
The wandering garter snake

T. e. vagrans was taken at four collecting sites (Island City, near Cove, La Grande, Medical Springs). The ecological relationship of this species to *T. sirtalis fitchi* was not clear, although the wandering garter snake apparently prefers a drier habitat and perhaps occurs at greater elevations.

Thamnophis sirtalis fitchi Fox*
Fitch's garter snake

This form was found in large numbers near Hot Lake. On October 30, 1953, three were found which would no doubt have been in hibernation were it not for the warmth of the nearby warm springs.

Coluber constrictor mormon Baird and Girard
The western racer

The western racer, recorded by Gordon from Elgin, was collected from four collecting sites (near Elgin, Hot Lake, Thief Valley Reservoir, Medical Springs).

On April 22, 1954, four individuals were found which showed the juvenile color pattern. These ranged from 276-326 mm. in total length.

Pituophis catenifer deserticola Stejneger*
The Great Basin gopher snake

Collected at Hot Lake and Thief Valley Reservoir, this form is probably quite abundant in the drier sections of the county. Both individuals were young, measuring 325 and 388 mm. in total length.

Crotalus viridis oreganus Holbrook*
The northern Pacific rattlesnake

Specimens were taken near Lookinglass in the northeastern part of the county and at Thief Valley Reservoir. Conversation with people of this area would indicate that the rattlesnake occurs over most of the non-forested parts of the county, with the exception of the Grande Ronde Valley.

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A New Species of Salamander from Central California

By JOE GORMAN

Following the re-discovery and description of *Hydromantes shastae* (Gorman and Camp, 1953) from Shasta County, California, I became impressed by the edaphic conditions of the habitats of the four known species: mainly limestone caves in Sardinia, Italy[1], and northern California, but granite in the high Sierra Nevada of California. A limestone belt runs northerly on the western slope of the Sierra, at about 1,500-3,500 feet elevation in the "Mother Lode" (gold) country of California. The known commercial limestone deposits in California were mapped from Logan (1947), including caves from the lists of the Stanford University and Southern California Grottos of the National Speleological Society. On a routine trip to Yosemite Valley for ecological data at a new site of *Hydromantes platycephalus*, a stop was made at about the center of a triangle of three such deposits. The habitat seemed likely for *Hydromantes*, sheer walls with mossy cracks and dripping water, and talus. The most unlikely aspect was that this site was on all-year State Route 140 to the Yosemite Valley resorts.

After turning about 30 rocks, I found a juvenile *Hydromantes*. In a few minutes, I found two more, and had reached a point about 25-30 feet up the cliff. Meanwhile my wife searched the base of the cliff, finding a large adult salamander which at a distance I took to be an *Aneides lugubris*. In the laboratory the next morning, the *"Aneides"* was found to be the only adult *Hydromantes* obtained, a seemingly much different member of the genus.

Hydromantes brunus, new species

Type. Museum of Vertebrate Zoology, University of California, No. 59530, a female, collected by Gerry Gorman, February 24, 1952, under a small rock at the base of low cliffs beside State Route 140, 0.7 miles NNE Briceburg (confluence of Bear Creek and Merced River), Mariposa County, California (fig. 1). The elevation at the roadside is 1,285 feet.

Description of the type (measured after preservation). Total length, 105.6 mm.; snout-vent length, 63.9 mm.; tail length, 41.4 mm.; head width, 11.5 mm.; front leg, 16.7 mm.; hind leg, 17.9 mm.; 13 costal grooves, including one each in axilla and groin; adpressed limbs touch but do not overlap; five eggs in right ovary, two in left, averaging about 4.6 mm. in diameter. Color (in preservative), medium brown above, orange-cream below except anterior half of belly, which is gray over liver.

Paratype. MVZ 55939, a male, collected by Robert C. Stebbins, February 27, 1952, under a moss-covered rock on the hillside above the site described for the type. Elevation about 1,450 feet.

Description of the paratype (measured after preservation). Total length, 98.5 mm.; snout-vent length, 63.2 mm.; tail length, 34.4 mm.; head width, 11.6 mm.; front leg, 17.8 mm.; hind leg, 18.5 mm.; 13 costal grooves, including one each in axilla and groin; adpressed limbs

[1]Benedetto Lanza (letter, November 14, 1951) states that these salamanders sometimes occur in sandstone.

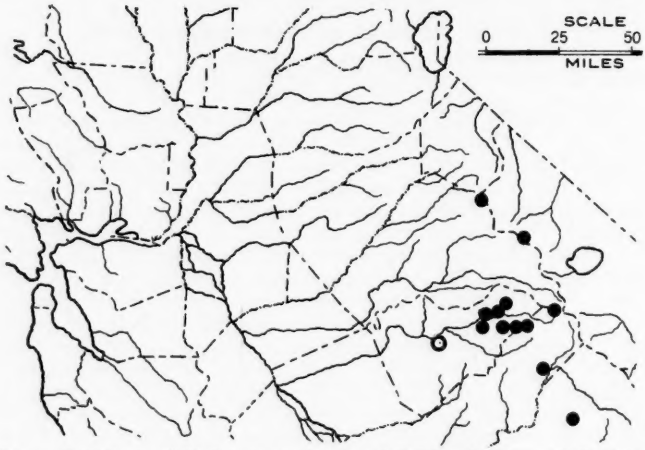


FIG. 1. Localities of *Hydromantes* in central California. Open circle shows the location of *Hydromantes brunus* at 0.7 miles north-northeast of Briceburg (confluence of Bear Creek and Merced River), Mariposa County, California. Solid circles show northern and most of known localities of *H. platycephalus*.

overlap about 1.5 costal grooves. Color, light grayish-brown above, yellowish-cream below.

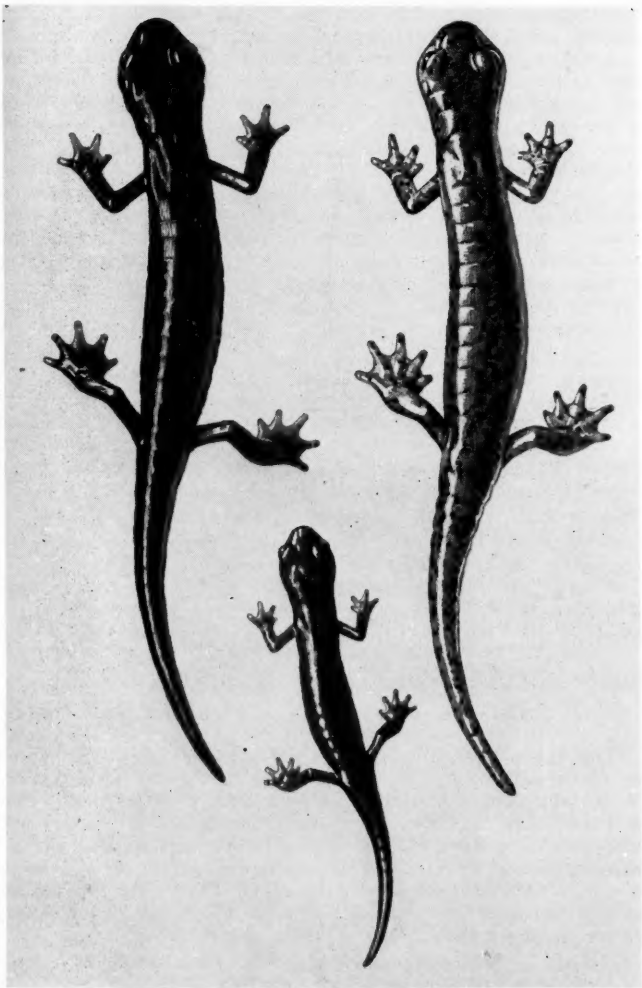
Comparisons. External characters establishing its generic identity (in California) with *Hydromantes platycephalus* and *H. shastae* are: the extensively protrusible tongue with tip a circular disc free all around, parasphenoid tooth patches separated, premaxillary teeth enlarged in adult males, toes blunt with webs extending less than halfway to tips, no palmar tubercles, tail blunt and subcylindrical, often carried free of substratum. The movements of the tail are synchronized with the animal's locomotion as described for *H. platycephalus* by Stebbins (1947).[2] Like *H. platycephalus*, *H. brunus* moves the tail from side to side, placing the tip on the substrate coincident with alternate movement of the hind legs, or on the down slope side when moving at an angle to the slope.

Adult *Hydromantes brunus* differ from *H. platycephalus* in their greater length. Proportionally the head is longer, eyes larger and less divergent, depth of maxilla greater, head width in males only slightly greater than in females, body less compressed dorsoventrally, tail and limbs much longer, and feet much larger with slightly less webbing between the toes.[3] Color differences are extreme (Pl. 1).[4]

[2]Tail movements were also described by Procter, 1921, for *H. genei*. She, however, considered the tip of the tail a tactile sense organ.

[3]The statistics upon which these statements are made concerning the morphology of species of *Hydromantes* will appear in a more comprehensive report.

[4]Illustration by Robert C. Stebbins.



PL. 1. Color differences between *Hydromantes brunus* from the type locality, 0.7 miles north-northeast of Briceburg, Mariposa County, California, and *H. platycephalus* from 3 miles west of the summit of Sonora Pass, Tuolumne County, California. Both adults are males. The juvenile, greenish in life, is the young of *H. brunus*. Measurements of snout-vent length of the individuals shown were, left to right, 64 mm., 31 mm., and 66.3 mm.

Hydromantes brunus adults almost entirely lack the bright guanoid coloring which gives *H. platycephalus* a mottled ash-gray, greenish-gold, to dull tawny or tan-beige color. Melanophores are extensively distributed, yielding a uniform light to dark brown dorsal coloring, lacking completely the varied chromophore[5]-melanophore patterns present in all other known species of the genus. Young, especially yearlings, of *H. brunus* differ markedly from the adults, and in some aspects of coloration seem intermediate between adult *H. platycephalus* and *H. brunus*. Like the adults the young also have weak development of melanin. In this respect they are readily distinguishable from young *H. platycephalus*. They have considerable guanoid coloring of silvery to greenish-gold. The latter color occurs where the guanoid chromophores are overlain by what appears to be a greenish yellow lipoid pigment. In resume, it seems that the basic color differences from *H. platycephalus* are the absence of the chromophore-melanophore pattern, ontogenetic loss of guanoid color, and the weak development of melanin.

Hydromantes brunus differs from *H. shastae* in its larger size. Proportionally, it differs from the latter in its longer tail, greater head width, smaller eyes, flattened head and body, shorter snout, and lack of a definite canthus rostralis. The feet are less webbed than in *H. shastae* and the toes are less blunt but longer. Color differences are analogous to the differences described for *H. platycephalus* and *H. brunus*.

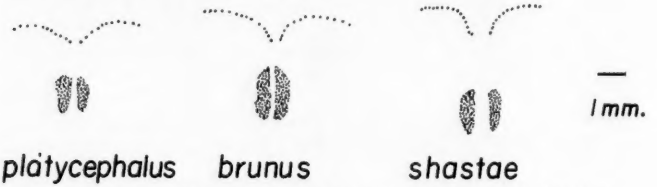


FIG. 2. Typical tooth patterns of California species of *Hydromantes*.

The typical tooth patterns of the California species of *Hydromantes* are shown in figure 2. The vomerine tooth rows of 10 *H. brunus* have 11-18 teeth on each side. Those of *H. platycephalus* have 9-18, and those of *H. shastae* 10-21 based on 10 individuals each. The rows do not meet in the midline and are less arched than in the other species. The premaxillary teeth of the male (not shown) are not so elongate in *H. brunus* as in *H. platycephalus* but more so than in *H. shastae*. The parasphenoid tooth patches in *H. brunus* are larger, less definite in shape, approaching but not meeting in the midline.

Habitat. The Briceburg habitat, the only known one, is an indistinct draw on a northeast slope, ending at cliffs formed mainly by a road cut. The hillside is chiefly limestone with numerous outcrops; however, the rocks at the base of the road cut are slate. Structurally, this habitat lacks the sheer walls of that of *Hydromantes platycephalus* or the cliffs and caves of *H. shastae*. I am reminded of the hillside sites of Central Ameri-

[5]Non-melanic chromatophores (see Gorman and Camp, 1953: 39).

can salamanders described by Dunn (1926) and Taylor and Smith (1945). *Hydromantes brunus* has been found only in an area not more than 100 yards across and about 1,200 yards along the slope, between 1,285 and 2,500 feet elevation. On several occasions, search has been made in equally likely looking habitats east on State Route 140 into Yosemite Valley.

The habitat is in the Upper Sonoran Life-zone. Digger pine (*Pinus sabiniana*), toyon (*Photinia arbutifolia*), California laurel (*Umbellularia californica*), manzanita (*Arctostaphylos* sp.), chamise (*Adenostoma fasciculatum*), buck brush (*Ceanothus cuneatus*), yerba santa (*Eriodictyon californicum*), Phacelia (sp.), and California wood fern (*Aspidum rigidum*) are the dominant flora, a chaparral association.[6]

Associated amphibians are *Aneides lugubris, Batrachoseps attenuatus* (*Ensatina eschscholtzi xanthoptica* occurs less than two miles south), *Taricha torosa sierrae,* and *Rana boylei.* The first two species occur with *Hydromantes brunus,* often being found at the same time under the same rock. In captivity, *Hydromantes brunus* has eaten *Batrachoseps attenuatus.*

In two years of intensive search for *Hydromantes* throughout California, including areas adjoining the Briceburg locality, I have found only the one *H. brunus* site. A special effort has been made to link *H. brunus* with *H. platycephalus* in Yosemite Valley, 25 miles east. Biosystematic studies of the genus, now nearly completed, suggest that *H. brunus* in some respects may be more generalized than any of the other species and hence (inferentially) the primitive species, represented by a few (or one?) relict populations. Until another population is found, I urge that collecting be done most sparingly. Furthermore, the population is under field study, individuals having been marked for future recognition. A minimum of disturbance is desirable. If marked animals should be recovered, I would appreciate obtaining data concerning them.

I am grateful to Dr. Robert C. Stebbins for his help and encouragement.

[6] I am indebted to the Herbarium, University of California, for aid in identification of plant specimens.

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Neutralization of Snake Venom in Vitro by Serum from the Nonvenomous Japanese Snake *Elaphe quadrivirgata*

By V. B. PHILPOT, JR.

During the author's tour of duty in Japan as an Army Medical Officer, it was learned that in the city of Tokyo there are some 75 snake shops that sell extracts of various organs and tissues of snakes for medicinal purposes. Among these preparations are powdered snake hearts, powdered snake flesh, strong rice wine containing a poisonous snake, and freshly drawn blood from the non-poisonous snake, *Elaphe quadrivirgata* Boie. These preparations are not prescribed and in fact are scorned by the reputable members of the Japanese Medical Profession. They are, however, used by many people in Japan for such a wide diversity of ailments as tuberculosis, heart disease, gastric ulcer, and nervous disorders.

Experimental evidence of the antivenin action of the serum from certain North American snakes (Philpot *et al.*, 1950) together with references to similar experiments using the serum of certain European snakes (Peterson and Koivastik, 1942, 1945; Phisalix, 1927) has previously been published. The present work was performed to test the antivenomous property of serum from the blood of *Elaphe quadrivirgata.*

Materials and Methods

The venoms used were from the North American copperhead (*Agkistrodon contortrix*) obtained through the courtesy of Wyeth, Inc., from Ross Allen's Reptile Institute, and the Japanese Habu (*Trimeresurus flavoviridis*) obtained through the courtesy of the National Institute of Health in Tokyo. These were kept in dry powdered form or frozen in solution of isotonic (.9%) sodium chloride until used.

The specimens of *Elaphe quadrivirgata* were purchased from snake shops in Tokyo. A portion of their tails was cut off and the blood

allowed to flow into a sterile container. Serum was separated from the cells by centrifugation, detoxified by heat at 56 C. for 30 minutes, and stored in the frozen state.

Experimental Procedure and Results

Neutralization of Habu venom. The toxicity of venom from the Japanese Habu was determined by intraperitoneal injection into 68 white mice of dosages of venom varying from 2.5 mg to 10 mg/kg in volume of normal saline solution of from 1.0 cc to .60 cc. The LD 50 (the dosage required to kill 50% of a given group of mice) as evaluated by the method of Miller and Tainter (1944) was 4.0 ± se. .28 mg/kg. The mice in this and all subsequent experiments were observed for a period of 48 hours after inoculation.

White mice were subsequently inoculated with 2½ LD 50 of Habu Venom (10 mg/kg) dissolved in isotonic (.9%) sodium chloride solution plus varying quantities of Elaphe serum as shown in Table I. This dosage of venom was without exception fatal to the 26 unprotected mice. When a dosage of Elaphe serum of 10.0 to 20.0 cc/kg or approximately 0.2 — 0.4 cc respectively per mouse was used in the diluent, 93% of a total of 27 mice survived. Inoculations were made after allowing the serum-venom solution to stand for 15 minutes at room temperature.

Neutralization of copperhead venom. After intraperitoneal inoculation of dosages of copperhead venom varying from 2.5 to 20 mg/kg into 68 mice, the LD 50, as calculated by methods in the previous experiment was found to be 5.8 ± se. .92.

White mice were subsequently inoculated with approximately 2½ LD 50s (15 mg/kg) of copperhead venom dissolved in 0.9% sodium chloride solution with varying dosages of Elaphe serum as shown in Table II. The solutions were allowed to stand 15 minutes at room temperature before inoculation. Although this dosage of venom was fatal to all of the 15 unprotected mice, 100% of the 16 mice protected by 20 to 40 cc/kg or approximately 0.4 to 0.8 cc per mouse survived.

Five white mice were each inoculated intraperitoneally with approximately 2 LD 50s (10 mg/kg) of copperhead venom mixed with heparinized normal human plasma at a dosage of 40.0 cc/kg, and incubated at 37 degrees C. for 30 minutes. All of these mice died within a 48-hour period. This observation precludes the possibility that the protection afforded by a corresponding dose of snake serum with an even greater dosage of venom is due to a simple non-specific protein effect.

Discussion

A dosage of 10.0 cc/kg of Elaphe serum protected 93% of mice against 2½ LD 50s of Habu venom whereas a corresponding dose of serum protected only 28% of mice against 2½ LD 50s of copperhead venom. This variation is so slight that it is impossible with the limited number of mice used to state whether or not it is significant. It might possibly be due to a slight excess in the dosage of copperhead venom in terms of LD 50s over that of Habu venom. If so, then there is probably no significant difference in the ability of serum from this reptile to neutralize the venom of the Japanese Habu and the American copperhead.

In contrast, a dosage of 0.8 cc/kg of American King snake serum

protected 93% of 31 mice against the lethal effects of 2½ LD 50s of the venom of the Florida rattlesnake (*Crotalus adamanteus*) (Philpot *et al.*, 1950). King snake serum is therefore approximately 10 times more effective against rattlesnake venom than Elaphe serum is against either copperhead or Habu venom. One possible explanation for this variation is that the snakes used in the present work were in a state of hibernation and had probably not eaten for several months.

Summary

Detoxified serum from the Japanese snake *Elaphe quadrivirgata* is capable of neutralizing the lethal effects in mice of snake venom from the Japanese Habu (*Trimeresurus flavoviridis*) and the American copperhead (*Agkistrodon contortrix*).

TABLE I

Neutralization of 2½ LD 50s of Habu venom by detoxified Elaphe serum.

Elaphe Serum cc/kg	No. mice inoculated	No. mice survived	% survived
20.0	13	12	93
10.0	14	13	93
5.0	10	0	0
0	26	0	0

TABLE II

Neutralization of 2½ LD 50s of copperhead venom by detoxified Elaphe serum.

Elaphe Serum cc/kg	No. mice inoculated	No. mice survived	% survived
40.0	5	5	100
20.0	11	11	100
10.0	11	3	28
5.0	10	0	0
0	15	0	0

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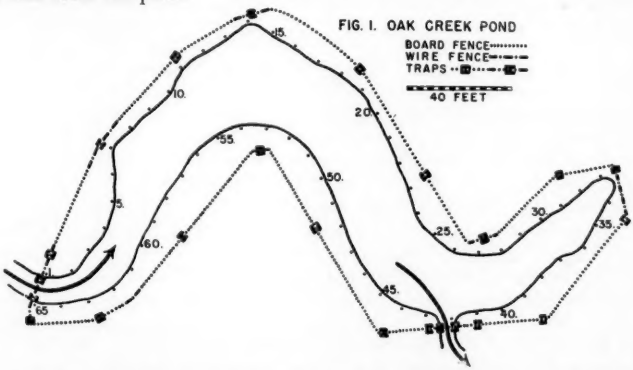
A Method for Studying Amphibian Breeding Populations*

By ROBERT M. STORM *and* RICHARD A. PIMENTEL

Introduction

The use of drift fences and funnel traps has been employed by several workers (Dargan and Stickel, 1949; Fitch, 1951; Gloyd, 1947; Imler, 1945; Woodbury, 1951 and 1953) with excellent results, mainly on reptiles. Stimulated by these results, it occurred to the authors that a small amphibian breeding pond might be entirely surrounded by fence, so that all animals moving to and from it could be shunted into funnel traps and recorded. Such a pond was available on property belonging to Oregon State College, 1¼ miles west of Corvallis, Oregon. This pond is located in a pastured area about 100 feet west of a small permanent creek, Oak Creek, and is part of an abandoned channel of Oak Creek, being elongated and narrow in outline (Fig. 1). It is temporary, usually filling up during October and becoming dry during the first part of June. This temporary feature insures a considerable annual movement of amphibians to and from the pond.



The pond, when filled, has a surface area of approximately 6,400 square feet, or about 1/7 acre. The shore line totals 650 feet and maximum depth is near 3½ feet. Grass and weeds grow heavily in the pond area during the dry season, contributing much rotting vegetation and emergent stems during the submerged season. Bank cover is negligible, consisting of grass and a few clumps of sedge. The inlet and outlet of the pond are indicated by arrows in Fig. 1. Water flow is not continuous during the winter season, but occasionally stops during periods of low rainfall.

MATERIALS AND METHODS

Fencing of the pond was commenced in the fall of 1950, funds for materials being provided from the General Research fund of Oregon State College. The fence was originally constructed of ¼-inch hardware

*Paper given in part at AAAS meetings in Corvallis, Oregon, June, 1952.

cloth, averaging about 10 inches above the ground with 2 inches buried beneath the surface. No effort was made to put a top on this fence, nor were special pains taken to secure the bottom of the fence at points where it crossed the inlet and outlet of the pond. Numbered reference stakes were placed every 10 feet at the normal high water edge. Twenty-four funnel traps were constructed and placed at what seemed appropriate spots along the inside and outside of the fence. Although the first few of those were constructed of hardware cloth, bronze window screen was soon substituted since, although less sturdy, it is easier to work with. Trap dimensions average 14 inches long by 6 inches wide by 5 inches high. Screen funnels, placed in each end, extend inward 3 inches to an opening 2½ inches long by 1 inch wide. It was found that once the screen had been cut to pattern, the pieces could be held together by using an Ace stapling machine. An opening was cut in the top to give entrance to the trap, the door being held in place by wires. Fitch's method (Fitch, 1951) of removing the funnel end in order to remove animals seems preferable since it is somewhat of a problem to keep the opening shut tight. The original rectangular trap was later modified into a cylinder, this being considerably easier to build. A corner could easily be crimped along one side so the trap would fit tight against the fence. These traps have proved quite effective for amphibians, but may allow snakes to escape, and mice move in and out at will. A swinging door could be installed, but was not attempted. Following the 1950-51 breeding season, the entire fence was removed since calves from the surrounding pasture had gotten in and destroyed considerable portions of it. Major defects of the fence the first year were frequent "washing out" under inlet and outlet fences at times of high water and climbing over the fence by at least *Ambystoma macrodactylum* and *Hyla regilla.*

Replacement of the fence was begun early in the fall of 1951. At that time it was decided that most of the fence could be made of boards, so an inexpensive tongue and groove siding was used, constructing the fence 3 boards high (each board 5 inches) and again burying the lower 2 or 3 inches. Being low-grade lumber, the boards contained many knotholes and cracks. These were covered with bronze window screen. Stretches of hardware cloth were substituted at the inlet and outlet and across low areas. In the inlet and outlet, the bottom of the fence was buried to a depth of 2 feet beneath the ground surface and large rocks were thrown into the opening along with the dirt fill. The entire fence was topped with a 6-inch strip of hardware cloth, fastened horizontally then bent downward 45° along each side. This fence proved satisfactory except for deep cracks developing along the bottom as the ground dried in the spring. This was alleviated during the 1952-53 season by distributing coarse sand along the fence, inside and out, the sand automatically filling the cracks as they developed. Eighteen more traps were constructed and placed for the 1951-52 breeding season and four were added in the 1952-53 season, the final locations of all traps being indicated in Fig. 1.

Marking each animal individually is a necessity in this type of study. It was the authors' original assumption that frogs could be marked by toe clipping, but that salamanders would regenerate toes within a few weeks.

Previous experience with the pond led to the belief that the main breeders in it were *Taricha granulosa, Hyla regilla,* and *Rana aurora,* with perhaps a few *Ambystoma macrodactylum* using it each year. It was decided to mark *Hyla* and *Rana* by clipping their toes, and specially numbered metal fingerling tags (Style 1005, Size 1, National Band and Tag Co., Newport, Ky.) were obtained for fastening into the fleshy dorsal portion of the tails of *Taricha.* These later proved unusable since they tended to tear loose eventually so that by the following year no salamanders retained these tags. Fortunately, all tagged specimens were also toe-clipped. It was felt that the few *Ambystoma* trapped could be at least temporarily marked by toe-clipping. A number code was set up for toe-clipping and each animal trapped was marked individually with this code. As expected, the clipping was satisfactory for frogs, but unsatisfactory for *Ambystoma macrodactylum,* which entered the pond in much larger numbers than anticipated (Table 1). Regeneration could be discouraged to some extent in *Ambystoma* by making a V-shaped cut back into the manus at the proximal end of the toe. However, toes regenerated nonetheless, so that repeat records in later years were largely unreliable. On the other hand, it was found that regeneration of *Taricha* toes could be largely eliminated by the V-shaped cut mentioned above.

BREEDING SEASON	SPECIES	*Taricha granulosa*	*Ambystoma macrodactylum*	*Dicamptodon ensatus*	*Rana aurora*	*Hyla regilla*	*Thamnophis sirtalis*	*Thamnophis ordinoides*
1950-1951	Number marked	82	44	-	6	152	4	1
	Total trapped	165	108	-	17	276	4	1
1951-1952	Number marked	97	387	-	6	160	1	-
	Total trapped	224	908	1	11	371	3	-
	Recaptured from previous years	4	7	-	2	31	-	-
1952-1953	Number marked	58	253	-	1	65	3	-
	Total trapped	152	621	-	7	112	4	-
	Recaptured from previous years	23	96	-	3	14	-	-

TABLE I

Numbers of amphibians and reptiles trapped, marked, and recaptured during three-year study. See explanation in text.

The following information was jotted down for each specimen as handled: number, sex, general remarks on size (if other than average), anomalies, the exact point of the observation, and notes on the breeding

stage of the females—mainly whether gravid or non-gravid. In addition, certain special observations were made for the different species: for *Taricha,* the degree of skin turgidity, for *Ambystoma,* the degree of brightness of the dorsal band, and for *Hyla,* the ground color and the extent and conspicuousness of the pattern. Exact sizes were obtained only for immature animals, largely because of lack of time and of proper facilities in rainy weather. Daily readings of the water level were taken. Water temperatures were taken with a hand thermometer during the first two seasons, but a continually recording Bendix-Friez distance thermograph was employed during the 1952-53 season.

Almost daily trap-checking was carried on through three breeding seasons, with inclusive trapping dates as follows: January 9-May 21, 1951; November 14, 1951-June 1, 1952; October 25, 1952-May 22, 1953. During the 1953-54 season, no regular trapping was carried on, although over 100 *Ambystoma macrodactylum* were brought in and preserved for further study. Results of the trapping during these three seasons is indicated in Table 1. In this table, "number marked" indicates the number of new animals marked each year. "Total trapped" indicates the total number of handling records for a species for a given season. For example, in 1952-53, only one new *Rana aurora* was marked and 3 old marks from previous years were caught. However, some of these frogs were trapped more than once, giving the figure "7."

DISCUSSION

As a method for study of amphibian breeding populations the present method has certain advantages as well as disadvantages. It gives a fairly accurate idea of the numbers of animals utilizing the pond, but it is felt by the authors that the effects of the fence on numbers became apparent in the third year. This is particularly true in the case of *Hyla regilla* where the number entering the pond in 1952-53 was 79 (65+14) as compared with 191 (160+31) in the previous year. Theoretically, one would hope to have the total trapping records amount to nearly twice the number entering the pond, since this would indicate that most of the entering animals left the pond following the breeding season. Some mortality can be expected in the pond, but the 1952-53 figure of 112 for *Hyla* seems much too low. The exact nature of this depleting effect is not known, although it is known that many *Hyla* die of dessication in the traps during April and May, at times when it is impossible to check the traps early enough in the day. During the coming breeding season, the senior author plans to remove considerable portions of the fence in order to see if the numbers take an upward swing. In the future, a sampling technique will be used, based on fewer traps plus individual trap use in the seasons already covered.

Aside from the above defect, a rather precise record of events in the breeding cycle can be secured. For example, in 1951-52, the following data were obtained on *Rana aurora*: first male entered pond prior to December 1, 1951; first female entered pond on January 31, 1952; first eggs deposited February 4; tadpoles began hatching from these March 15; tadpoles, not yet with front legs, dying of heat in very shallow muddy water on May 25. For *Hyla regilla,* the following data were obtained: first

male entered pond January 16, 1952; first female entered pond January 26; first eggs noted February 28; hatched tadpoles seen April 15; first transformed frogs noted May 20. For the less secretive forms like *Hyla regilla*, the fence and traps might not be necessary to obtain this information, but for such very secretive amphibians as *Ambystoma macrodactylum* and *Rana aurora*, similar information would be impossible without them. Other precise data can be obtained such as sex ratios, nature of movements to and from the pond, coordination with climatic features, variations in any particular features of a species—either between individuals or within individuals with time, etc. Planned papers on the forms involved will make use of the data obtained.

The problem of properly marking *Ambystoma macrodactylum* remains to be solved. During the 1952-53 season, all *Ambystoma* were marked with 2 notches in the upper edge of the tail, in addition to the toe-clipping. Several of these returned during the 1953-54 season, the healed notches being quite evident. This may provide a means of mass-marking small individuals, but does not solve the problem of individual marking.

SUMMARY

1. A small temporary amphibian breeding pond was completely fenced so that all animals entering and leaving the pond could be trapped in funnel traps and individually marked.

2. Total separate individuals recorded in a three-year study were as follows: *Taricha granulosa*–237; *Ambystoma macrodactylum*–684; *Dicamptodon ensatus*–1; *Rana aurora*–13; *Hyla regilla*–377; *Thamnophis sirtalis*–8; *Thamnophis ordinoides*–1.

3. All animals were marked by toe-clipping. In addition, during the first year, *Taricha granulosa* was marked with numbered metal fingerling tags, clamped in the dorsal part of the tail. These tore loose within a few months. Toe-clipping proved satisfactory on frogs and *Taricha granulosa*, but regeneration of some *Ambystoma macrodactylum* toes made recapture data useless.

4. Advantages of this method are accurate census of numbers using the pond (in early part of study); precise records of events in the breeding cycle; movements, sex ratios, variation, etc.; close correlation of amphibian activities with climatic factors; and a generally more accurate idea of the population dynamics of the species involved.

5. Main disadvantages of this method are initial expense and labor; appreciable lowering of numbers utilizing pond, probably due to the presence of the fence; and increased chances for error due to usually disagreeable field conditions and the mechanics of the project.

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A CASE OF CANNIBALISM IN THE TOAD *BUFO BOREAS HALOPHILUS*.—Following a summer thunderstorm of considerable magnitude, toads were collected during the late afternoon and early evening of July 28, 1952, in the Hesperia region of the Mojave Desert in San Bernardino County, California. This area is situated at an elevation of 3,000 feet at the northern base of the San Bernardino Mountains, where Deep Creek flows into the Mojave River.

The sky was still overcast and the ground was very damp. Dips in the road were filled with water and many stretches of the highway were covered with almost an inch of silt. The Mojave River, usually flowing underground in this section of the desert, was a raging torrent and spread over a wide area.

Bufo boreas halophilus was very common along the banks of Deep Creek and some sixty large specimens were collected in less than one hour. One toad, sitting near the edge of the stream, looked somewhat peculiar and upon inspection it proved to have a smaller specimen of the same species protruding from its mouth. The smaller toad was dead and measured 17mm. in snout-vent length while the larger toad measured 48mm.

Later in the evening more toads were collected and thousands were seen hopping across the road but no further cannibalistic tendencies were observed. These toads were so numerous that it was impossible to avoid running over a large number of them. The following morning there were many hundreds found flattened on the highway.

This appears to be the first record of cannibalism in adult toads of this species.—John D. Cunningham, Department of Zoology, University of California, Los Angeles 24, California.

New and Additional Herpetological Records from the North Carolina Coastal Plain

By ALBERT SCHWARTZ *and* RICHARD ETHERIDGE

Two recent papers (Robertson and Tyson, 1950; Eaton, 1953) have dealt with the herpetofauna of eastern North Carolina. Previously, Brimley (1939-1943) had published a list embracing the herpetofauna of the entire state, and Brandt (1936) had studied the salientian fauna of the eastern portion of the state, with observations centering in Beaufort County. This coastal area is intermediate between South Carolina and the Dismal Swamp region of North Carolina-Virginia, a locality where many southeastern Coastal Plain species find the northernmost stations of their distribution. Despite previous thorough collecting in the area, several interesting observations and specimens have recently been secured in this region by us, and it is suitable at this time to record these, insofar as they shed some light upon the distribution of certain forms in North Carolina as well as in the southeast.

Ambystoma cingulatum cingulatum Cope. On March 28, 1954, we took a series (ChM 54.44.16) of eight larvae of this form from a borrow pit, 4.5 mi. E Supply, Brunswick County. These specimens represent the first record of this species for North Carolina and a range extension of approximately 170 miles to the northeast from the previous most northern record of Colleton County, South Carolina (Goin, 1950: 315). The borrow pit from which these larvae were seined measures about forty by fifteen feet, is about 1½ feet in depth, and is located in cut-over pineland. The water was clear, but large amounts of submerged aquatics and algae were present near the bottom of the pit. Tadpoles of *Pseudacris ornata* and adult *Notophthalmus v. dorsalis* were also taken in the seine.

The larvae resemble closely in detail those described by Orton (1942) for *A. cingulatum* from Jackson County, Florida. Since their description, these larvae have been referred to *A. c. bishopi* by Mecham and Hellman (1952: 129-30). In life, the ventrolateral stripe is definitely bluish-gray in color, whereas the dorsolateral stripe is dark brown to black. The larvae range in length from 51 to 37 mm. in total length. Comparison of these specimens with the illustration given by Mecham and Hellman (*loc. cit.*) shows that the present larvae are less definitely and less boldly marked; this is almost certainly due to the smaller size of the present material, which is more comparable in head and body length to Orton's material.

There is a possibility that these larvae are not the larvae of *A. cingulatum*. This is predicated upon the previous lack of information concerning the distribution of the frosted salamander in North Carolina, and the known occurrence in this area of *Ambystoma mabeei*. Members of the genus which have been taken in the eastern coastal region of North Carolina include *A. opacum*, *A. t. tigrinum*, *A. mabeei* and *A. maculatum*. *A. talpoideum* has not been collected in the North Carolina Coastal Plain, but might be expected to occur there. Of these salamanders, only *A. mabeei* has 13 costal grooves, whereas the remaining local members of the genus have from 10 to 12. There is thus the possibility, since these

larvae have from 13 to 15 costal grooves (by present counting), that they are the larvae of *A. mabeei.* However, they bear no resemblance to the description of *A. mabeei* larvae as described by Jopson (1940: 40), who likens the larvae of this form to those of *A. opacum,* except that the latter have light, rather than black, bellies. Their close resemblance to published data on the larvae of *A. cingulatum,* on the other hand, makes it probable that they represent this species and we have consequently designated them as such. A trinomial is used merely on the basis of geographic provenance of the specimens; although the data are far from conclusive, there seem to be no trenchant differences between the larvae of the race *bishopi* (as known from Orton's description and figure) and the present specimens of the race *cingulatum.*

Stereochilus marginatus Hallowell. This relatively rare salamander was taken at two localities in North Carolina by us. Five specimens (four as ChM 54:44.12 and one in the personal collection of Etheridge) were collected 8.8 mi. NE Holly Hill, Onslow County, on March 28, 1954. Robertson and Tyson (*op. cit.*: 133) took four specimens in Pitt County; these were secured under logs in extremely muddy, recently flooded areas of cypress swamp. Brimley (*op. cit.*: installment 6, p. 2) mentions taking specimens in semi-stagnant pools. The present lot of specimens (three males, snout-vent lengths 43, 47, and 48 mm.; two females, snout-vent lengths 43 and 50 mm.) was secured in about twenty minutes by dipping in a sphagnum-clogged ditch, in which the water was slowly flowing, at the side of the road. Almost certainly a much larger series could have been secured, had collecting persisted. The salamanders were found wriggling through the mass of sphagnum when it was placed upon the bank; several larval *Desmognathus f. auriculatus* were also secured. This may offer a clue regarding collecting of this scarce salamander in areas where sphagnum is prevalent.

On the previous day (March 27, 1954), 8.5 mi. S Chocowinity, Beaufort County, we secured a female *Stereochilus* (ChM 54.44.5) and her eggs. This is the first record of this salamander being taken with eggs in the field, although artificially induced eggs were reported by Noble and Richards (1932). The salamander was found beneath a log (about 2 feet in length and 6 inches in diameter) lying in the moist sand at the edge of a flooded borrow pit. There were 15 eggs and the female (snout-vent length, 50 mm.) was lying curled close beneath them, in the fashion of *Desmognathus fuscus.* Both eggs and adult were about two inches above the water level in the pit. The eggs were pedicellated, definitely drop-shaped, and attached firmly to the underside of the log. Each of the fifteen eggs contained a well-developed larva. Both eggs and female were placed in a collecting jar at once, and immediately several of the larvae escaped from the egg envelopes. By the time that the lot reached Charleston on March 29, all the larvae had hatched. Consequently, no measurements of the eggs or their membranes were possible. The fact that the eggs were not in the water, that the female was accompanying them, and that the larvae escaped their oval confines upon immersion of the eggs in water is reminiscent of the normal pattern of oviposition and hatching in *Ambystoma opacum.* Noble and Richards reported that the eggs are

deposited in water, and are attached singly to a support. Of twenty females which were induced by these workers to deposit eggs, three laid their clutches on the underside of sheet moss; Noble and Richards illustrate the manner of deposition and attachment for the species and mention that (*op. cit.*: 6), of one individual, "the ovipositing female invariably turned over on her back before egg-laying." That the eggs were laid singly and scattered in water weed or free in the water is probably attributable to the artificial conditions under which the eggs were deposited. The inverted position of the female during laying and the attachment of the eggs to the underside of objects is probably characteristic of the species. These differences in place of deposition as well as the difference in number of eggs (121 eggs as an extreme; average of 19 clutches was 57 in eggs in induced deposition, 15 eggs found by us in nature) are also striking. The finding of additional clutches in the field will indicate whether the eggs are deposited customarily in water or on land, and the number of eggs per clutch. Another possibility is that the eggs may be laid under and attached to an object in the water, but are able to survive the recession of the water from the nest site and thus to survive also lack of immersion during part of the development. Actual hatching will then require re-immersion.

The hatchling larvae of *Stereochilus* have not been described. A typical individual is shown in Figure 1. The larvae are sharply bicolor, dark brown dorsally, and yellow (due to the yolk) ventrally. The heavy spotting on the head and body is bold; these spots are white dorsally and yellowish-white or yellow where they overlie the yolk material. The tail fin is almost entirely unpigmented and hyaline; along the midline of

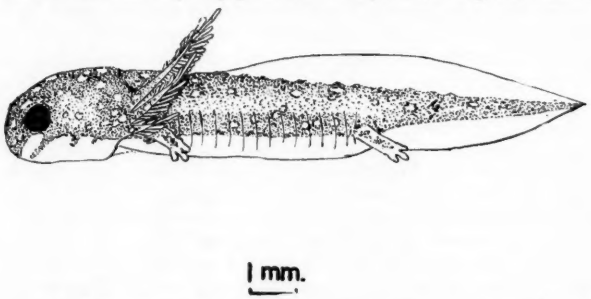

Fig. 1. Hatchling larva of *Stereochilus marginatus*. Total length 13 mm.

the dorsum at the base of the fin are black, isolated chromatophores which alternate with faintly yellow isolated chromatophores in the base of the fin itself. When viewed dorsally, there is thus a yellowish mid-dorsal line which stands out boldly from the surrounding brownish dorsum. The chin is white. The gills are faintly pink, and the rachises are slightly pigmented with brown; the white spotting extends partially onto the rachises. The forelimbs have three digits well developed and the fourth represented by a small excrescence; the hindlimbs have three toes. The

mouth apparently is unopened at hatching, and much yolk material is present. The eye is black and the iris completely unspotted. When resting the larvae lie on the bottom on their sides, but are generally very active and sensitive to stimuli. The average total length of fourteen hatchlings is 13.1 mm., with an observed range of 11.3 mm. to 13.8 mm.

Rana capito capito Le Conte. This frog was first recorded from North Carolina by Brandt (*op. cit.*: 220-1), who heard males calling on March 16, and captured a male on March 19, 1953. He regarded this species as the rarest frog of the region, "having been observed only a few times in Beaufort County." This has been the only record of this frog for the state, and the capture of a second specimen (ChM 54.44.7) on March 27, 1954, at 2.4 mi. N Maysville, Jones County, is worthy of record. This individual, an adult male (snout-vent length, 90 mm.; tibia, 43 mm.), was taken beneath a log six feet in length and 1½ feet in diameter lying in mud at the edge of a borrow pit. The frog was lethargic when captured and showed interesting tonic posturing. The back was steeply arched and the head bent between the front legs with the hands covering the sides of the head. The eyes were closed. The hind legs were normally folded and drawn tightly to the sides of the body. The amphibian was completely undisturbed by handling and persisted in this posture while it was examined and placed in a collecting sack. In the laboratory, it could be made to call readily after it had assumed its normal posture and had lost its lethargy. No egg masses of *R. c. capito* were noted in the pond and no males were heard calling, despite a heavy and continual rain in the afternoon and evening of March 27. The readiness with which this individual could be made to call in the laboratory and the taking of the specimen in proximity to a flooded borrow pit tend to affirm Brandt's March 16 breeding record for this same general region.

Natrix rigida Say. Although this water snake is known from South Carolina to the south and Virginia (Richmond, 1940) to the north, there appears to be no record for the species in North Carolina. A single male individual (ChM 54.44.14) was taken on March 27, 1954, at 1.9 mi. N Maysville, Jones County, under a log lying in the water of a shallow but extensive borrow pit. The snake was completely immersed in the water and was inactive when secured. The specimen measures 414 mm. in length, the tail making up 94 mm. The color and pattern are usual for the species (as known by specimens from South Carolina). This snake was kept alive in the laboratory for a week and during this time fecal material made up of the fragments of chitinous crayfish exoskeleton was discharged.

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A LATE AUGUST BREEDING OF *HYLA CINEREA* IN FLORIDA.—*Hyla cinerea cinerea* (Schneider) is reported as breeding from April 15 to August 15 over the whole of its range (Wright and Wright, Handbook of Frogs and Toads, p. 305), and "from late spring to late summer, limiting dates being about the last of April and the middle of August" (Kilby, Quart. Jour. Fla. Acad. Sci., 8: 82) in the Gainesville area of Florida. Kilby (idem) noted that "the condition of the weather is a controlling factor in determining when, within this period, breeding actually occurs." Since this species is rather widespread over the southeastern United States, it seems likely that geographical location may also relate to the time of breeding.

On the evening of August 25, 1948, near Braden Castle in Bradenton, Florida, Dr. Allyn Waterman and myself heard several members of this species calling after dark on the bank of the Manatee River. A few of the amphibians were captured on a rather sandy flat in small isolated shallow water pools, and were kept in a jar overnight. By the following morning, one of the captive females had spawned rather profusely. Although a visit on the morning of the 26th to the site of capture did not reveal any of the eggs, the behavior of the single female and the evening singing of the 25th indicated that active breeding was taking place. The date of August 25 appears to extend to late August the recorded breeding activity of this species.—James M. Moulton, Department of Biology, Bowdoin College, Brunswick, Maine.

TROPIDOCLONION LINEATUM LINEATUM (Hallowell) IN NEW MEXICO.—Recently L. W. Ramsey (Herpetologica 9(1): 7-24,4 figs. 1953) partitioned the single species of the genus *Tropidoclonion* into three subspecies and included in the northern one, *T. l. lineatum* (Hallowell), an isolated population reported from Colorado by T. Paul Maslin (Herpetologica 6(3):89-95. 1950). The purpose of this note is to report an extension of the range of this western population, an extension that constitutes an addition to the known herpetological fauna of New Mexico.

On 31 July, 1939, Koster collected an adult female of this species near one of a series of small, isolated pools in the bed of an intermittent stream about 12 miles northwest of Santa Rosa, Guadalupe Co., New Mexico. The surrounding area was grassland. Some years later, 10 September, 1950, Maslin collected an additional adult female beneath some trash on a grassy bank of the Mora River at Watrous, Mora Co., New Mexico; and three years later, 18 April, 1953, collected three more females and two adult males at the same locality. In all of these specimens the counts uniformly are: supralabials 6-6, infralabials 6-6, preoculars 1-1, postoculars 2-2, scale rows 17-19-17 except the specimen from Guadalupe Co., which has a scale row formula of 17-17-17. The ventral and subcaudal counts are as follows:

Specimen	Locality	Ventrals	Subcaudals	Ventrals plus Subcaudals
U. Colo. Mus..... 6495 ♀	Mora Co.....	138+1	34	172
U. Colo. Mus..... 6528 ♀	Mora Co.....	136+1	33	169
U. Colo. Mus..... 6529 ♀	Mora Co.....	137+1	32	169
U. Colo. Mus..... 6530 ♀	Mora Co.....	136+1	32	168
U. N. Mex. Coll. 102 ♀	Guadalupe Co.	141+1	35	176
		137.6+1	33.2	170.8
U. Colo. Mus..... 6526 ♂	Mora Co.....	137+1	45	182
U. Colo. Mus..... 6527 ♂	Mora Co.....	142+1	43	185
		139.5+1	44.0	183.5

Curiously, the above scale counts are much closer to those of both *T. l. lineatum* (Hallowell) and *T. l. texanum* Ramsey than they are to those of the geographically closest subspecies, *T. l. annectens* Ramsey, and the counts are sufficiently intermediate to suggest that a population of intergrades is represented. However, since the number of specimens is small, and since there is greater tendency toward the first named, we, tentatively, and in line with Ramsey's treatment of the Colorado population, assign this population to *T. l. lineatum* (Hallowell).—T. Paul Maslin, University of Colorado Museum, University of Colorado, Boulder, Colorado and William J. Koster, University of New Mexico, Albuquerque, New Mexico.

Salamanders of the *Ambystoma jeffersonianum* Complex in Indiana

By SHERMAN A. MINTON, JR.

Students of North American salamanders have long suspected that the species *Ambystoma jeffersonianum* (Green) is a composite of two or more forms. The nominate form, described as *Salamandra jeffersoniana*, was taken in southwestern Pennsylvania, probably in the vicinity of Washington or Canonsburg. Hallowell (1856) described *Ambystoma laterale* from the southern shore of Lake Superior near Marquette, Michigan. In 1865 he described *Ambystoma fuscum* from a specimen collected near Hanover College in southern Indiana. Cope (1867) described *Amblystoma platineum* from specimens collected near Cleveland, Ohio, and the Moose River in Canada. He considered *laterale* a subspecies of *jeffersonianum*. In his monograph of the North American batrachia, Cope (1889) designated a specimen in Dr. Green's collection from western Pennsylvania (U.S. National Museum 3968) as the type of *Ambystoma jeffersonianum jeffersonianum*. He recognized *laterale* and *platineum* as subspecies and reduced *fuscum* to the synonomy of *jeffersonianum*. Recent workers have not found this arrangement satisfactory, and most have regarded *Ambystoma jeffersonianum* as a monotypic species.

Clanton (1934) called attention to the existence of two variants of Jefferson's salamander in the vicinity of Ann Arbor, Michigan. One form was small, dark, and produced 120-300 eggs which were small and lightly pigmented. The other was larger, lighter, and produced 50-216 eggs which were larger and more heavily pigmented. Salamanders of the light form were almost invariably females. Dark females ranged in total length from 82 to 134 mm. with a mean of 104 mm., while light females ranged from 93 to 142 mm. with a mean of 120 mm. Matings between light females and dark males produced only females of the light variety. The ratio of females to males was as high as 50 to 1 in some places. The light females were considered hybrids between two forms that had been geographically isolated and subsequently reunited. Clanton further pointed out that spermatophores of Jefferson's salamander from central Pennsylvania differ in size and shape from those deposited by the dark Michigan form. Bishop (1941, 1943) recognized the existence of a dark, small race of Jefferson's salamander in western New York and the Middle West.

Ontogenic and seasonal changes in color and pattern have always proved a difficulty in the study of salamanders of this complex. Many pattern details are lost in preserved material. Misidentifications in this group have always been common and usually entail confusion with *Ambystoma texanum* and *Plethodon glutinosus*.

Early in the course of field observations on Indiana salamanders, I was impressed with the difference between the large, gangling, lead-colored *Ambystoma jeffersonianum* of southern Indiana and the smaller, darker, more compactly built specimens from the Indiana Dunes. Subsequent experience in the state has confirmed the existence of two forms.

I believe the larger is identifiable with *Ambystoma jeffersonianum* while the smaller is a distinct species for which Hallowell's name, *laterale*, is available. It may be argued that Hallowell's diagnosis of *laterale* might apply equally well to a juvenile of either form, but the available evidence indicates that only the small, dark species is to be expected on the southern shore of Lake Superior. The forms may be recognized as follows:

Ambystoma jeffersonianum: Body length (measured from the tip of the nose to the posterior angle of the vent) at sexual maturity 70-75 mm. for males, 75-80 mm. for females. Toes of adpressed limbs overlapping 1½ to 2 costal folds in adult males and nearly always at least touching in adult females. Tail 43-52 percent of the total length in adults. Dorsal color in life brownish grey, dark brown, or lead color becoming paler in preservatives. Pale bluish grey lichen-like markings mostly confined to sides of trunk and tail. Belly pale bluish grey to brownish grey, unmarked or with fine light punctations.

Ambystoma laterale: Body length at sexual maturity 47-55 mm. in both sexes. Toes of appressed limbs not overlapping more than one costal fold in adults of either sex and often failing to touch in adult females. Dorsal color in life dark brown to black becoming lighter in preservatives. Numerous pale blue to bluish white flecks on dorsum; frequently small, discrete bluish-white spots on sides of trunk and tail. Ventral surface dark grey to greyish brown with numerous small light spots on belly and throat. Tail 38-47 percent of the total length in adults.

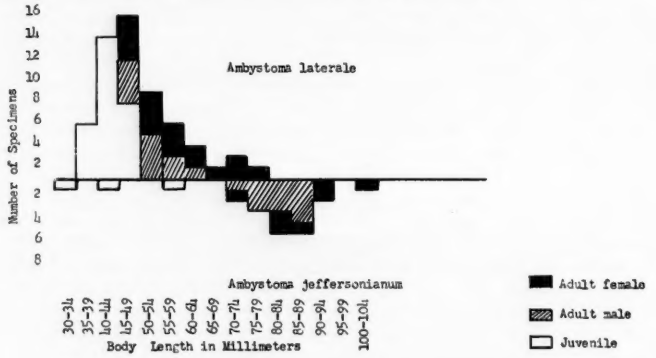

Figure 1. Comparison of body length in Ambystoma jeffersonianum and Ambystoma laterale.

The pronounced size difference between the two species is shown by Figure 1. Specimens of *laterale* with body lengths of 47-50 mm. have shown apparently ripe eggs on dissection, and males of this size have the cloaca swollen. A specimen with a body length of 57 mm. was taken in the act of depositing eggs. The largest typical specimen of *laterale* has a body length of 75 mm. and a total length of 127 mm. Two larger specimens are atypical in other respects and are discussed separately. In con-

trast, the smallest male *jeffersonianum* from the breeding ponds have body lengths of about 75 mm., no ripe eggs are found in a female of 72 mm., and a specimen of 56 mm. body length is too immature for sex to be determined. The largest specimen has a body length of 101 mm. and a total length of 209 mm. In a series of 16 adult or near adult *jeffersonianum*, the ratio of males to females is 1.28 to 1 while in a comparable series of 25 *laterale*, the ratio is 1 to 1.82. Immature *jeffersonianum* are relatively rare in collections from Indiana while immature *laterale* are rather plentiful.

The ratio of head width to body length which Cope (1889) relied upon in separating the three subspecies he recognized does not satisfactorily separate *jeffersonianum* from *laterale*. In specimens with a body length of 70 mm. or more, the ratio in *jeffersonianum* ranges from 13.9 to 18 percent with a mean of 15.97 percent. This ratio in *laterale* with a body length of 45 mm. or more ranges from 14.8 to 18.1 percent with a mean of 15.88 percent. The head gives the impression of being wider in *jeffersonianum*, probably because this species is less compactly built than *laterale*. Viewed from above, the snout of *jeffersonianum* is wider and more blunt than that of *laterale*.

The limbs are slightly longer in *jeffersonianum* and the toes decidedly more attenuated. In only two *jeffersonianum*, both females, do the toes of the appressed limbs fail to touch, whereas they fail to touch in 31 per cent of adult or near adult *laterale*. A maximum overlap of two costal folds is seen in adult males of *jeffersonianum* and a maximum overlap of one costal fold is seen in *laterale*. A costal groove count of 12 is seen in 55.5 per cent of *laterale* and 31.6 per cent of *jeffersonianum*, a count of 13 is seen in 40 per cent of *laterale* and 57.9 percent of *jeffersonianum*, a count of 14 in 10.5 per cent of *jeffersonianum* and a count of 11 in 4.5 per cent of *laterale*. In adult *jeffersonianum* males, the tail makes up 49 to 52 per cent of the total length (mean 50.5 per cent) and in adult females 43 to 51 per cent (mean 47.2 per cent). For adult *laterale*, the corresponding figures are 41 to 47 per cent (mean 43.9) for males and 38 to 46 per cent (mean 42.3) for females. The tail in *laterale* is more fleshy and less laterally compressed than in *jeffersonianum*.

The color differences are usually striking enough to permit living adults to be separated without difficulty. The light dorsal spots and flecks are distinct in *laterale* and contrast strongly with the very dark ground color. The impression is one of a spotted or speckled salamander similar to *Plethodon glutinosus* with which it has more than once been confused. *Ambystoma jeffersonianum*, on the other hand, gives the impression of an unmarked greyish or brownish salamander whose sides are somewhat lighter than the back. Light dorsal flecks, if present, are small and stellate. The belly in *laterale* is much darker than in *jeffersonianum* and usually shows distinct light flecks. Both species appear darker during the warm months than during the early spring or late winter breeding season. Metachroic change in these salamanders was investigated in a crude experiment involving two typical *Ambystoma laterale*, one typical *A. jeffersonianum*, and one presumed *laterale-jeffersonianum* hybrid. All were adult females captured in ponds during the last week of March. At the

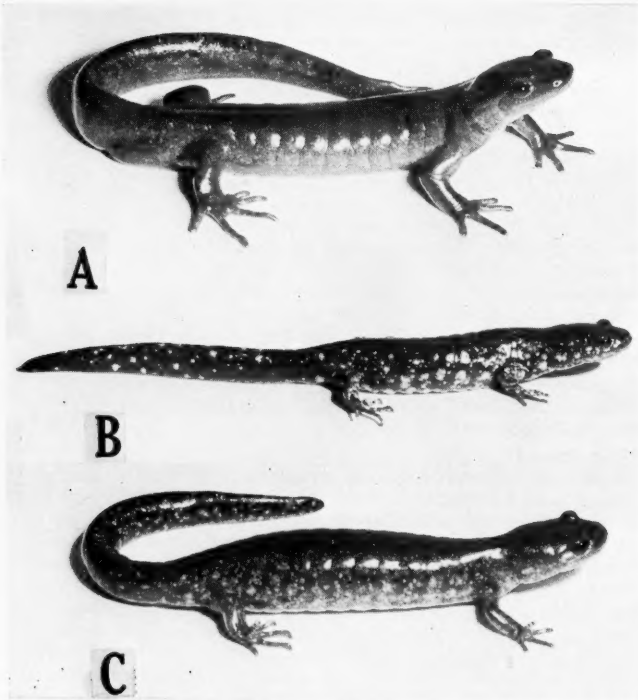

FIG. 2 A. Adult male *Ambystoma jeffersonianum*, length 173 mm. Collected at Silver Hills, Floyd County, Indiana.
B. Adult female *Ambystoma laterale*, length 120 mm. Collected near Tremont, Porter County, Indiana.
C. Presumed hybrid *Ambystoma laterale* x *jeffersonianum*, length 140 mm. Collected near North Liberty, St. Joseph County, Indiana.

—Photographs by Isabelle Hunt Conant

time of collection, the *jeffersonianum* was light greyish brown with lichen-like bluish grey mottling on the sides of the trunk and tail; the *laterale* were dark purplish brown with profuse bluish white pigmentation of the sides and back. The light marks ranged from a fine speckling to large "snowflake" blotches. The hybrid specimen closely resembled the *jeffersonianum*, but was a little darker. Under none of the captive conditions were the animals ever seen so light-colored as when observed in the field. All the salamanders were somewhat darker after overnight exposure to temperatures of about 35 F. in a bucket of pond water. The *laterale* had lost their frosted appearance, but retained pale blue mottling of the sides

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of the trunk, tail, and dorsal aspect of the limbs. The *jeffersonianum* was no longer greyish, but presented a generally brown appearance with small, blue-white, stellate flecks. The hybrid was also brownish with heavy pale blue mottling on the sides of the trunk. A night's exposure to temperatures of about 30 F. in a moist, glass-covered terrarium did not appreciably alter the color of the animals. The terrarium was then brought indoors for 24 hours at temperatures of 70-75 F. An electric light bulb was placed a few inches from the terrarium lid and turned on until the temperature in the terrarium had risen to 88 F., close to the maximum tolerated by the animals. After this exposure, the *laterale* were coal black above and below with intense pale blue pigment distributed as previously noted, but reduced until it was predominantly in discrete spots and flecks. The *jeffersonianum* was dark seal brown above and only a trifle lighter below. A few small bluish punctations were seen on the limbs and sides of the trunk. The hybrid was also dark brown, but showed considerable blue speckling on the sides of the trunk, throat, and belly.

Two newly-transformed *jeffersonianum* with gill stubs still visible were collected June 22. Their body lengths were 31.5 and 39.7 mm. Both were dark olive brown with indistinct yellowish mottling on the sides. The larger showed a few tiny bluish spots on the limbs and body. I have not seen newly-transformed *laterale*. The smallest juveniles examined have body lengths of 35 to 38 mm. and show very distinct light dorsal spots. A specimen of *jeffersonianum* with a body length of 56 mm. is more spotted than the adults; however, the spots are stellate, and the ground color above and below is paler than in *laterale*. A study of the eggs, larvae, and comparative life histories of the two forms is in progress.

It is hardly surprising that puzzling specimens are occasionally encountered in this group of salamanders, particularly in examination of preserved material. In certain cases, allocation of the specimen may well be impossible. Two examples of the all-female hybrid have been examined in Indiana material. Both have body lengths of about 77 mm. and total lengths of about 140 mm. They have the shorter toes and tail of *laterale*. One, the animal illustrated in Figure 2b, more closely resembles *laterale* in color and pattern; the other, described in the experiment on metachroic change, more closely resembles *jeffersonianum*. A juvenile from the Indiana Dunes near Miller (CA 12791) is much lighter than other material from this part of the state and virtually without pattern. It may be an example of the hybrid form or may owe its appearance to some variation in preservation. A newly-transformed specimen from Allen County, Indiana (USNM 50926), cannot be identified because of its immaturity and rather poor preservation.

Elucidation of the taxonomic status of the two forms awaits examination of specimens from all parts of the range of the complex and further observations on the life history in various areas. They have tentatively been assigned full specific status on the basis of my interpretation of Clanton's evidence. If it is true that *jeffersonianum-laterale* matings produce a population consisting almost entirely of females whose matings with normal males likewise produce only hybrid females, it follows that a steadily increasing number of hybrid females will compete with normal

females for the spermatophores of an ever decreasing proportion of males. This will result in extinction of populations in the zone of range contact unless there is steady migration of normal males into the area in rather large numbers. The abnormal character of some populations sampled by Clanton and others indicates that they can scarcely persist through many more breeding cycles. Thus the seeming inability of these forms to produce a self-perpetuating intergrade population constitutes reproductive isolation and warrants the recognition of both forms as species.

It is a reasonable hypothesis that the range of the common ancestor of *jeffersonianum* and *laterale* was divided by the post Pleistocene eastward extension of the prairie steppe which created an unfavorable habitat for these woodland animals. To the north of this zone, *laterale* differentiated, and to the south, *jeffersonianum*. With the subsequent succession of the prairie by forest, the forms were again brought into contact with resultant hybridization.

The range of *laterale* in Indiana lies entirely within the northern Lake Plains. It is characteristically found in wooded, swampy places where the soil is sandy. The majority of specimens examined have come from the Indiana Dunes and from swampy oak openings in northeastern Jasper County. *Ambystoma jeffersonianum* seems fairly well distributed through the hilly country of southern Indiana and probably was found throughout wooded sections of the central Till Plain as well. Neither species has been detected in the lower Wabash and Ohio valleys nor in actual prairie habitats, although *laterale* may occur in patches of woodland surrounded by prairie. A scarcity of specimens from the probable zone of range contact in Indiana may indicate that the "Clanton effect" has already caused extinction here, although disturbance of the habitat by agriculture certainly cannot be discounted. The small, shallow forest ponds which these species use for breeding have been extensively filled, drained, or converted into deeper ponds which are unsuitable for salamanders.

The status of these forms in New England and southeastern Canada warrants further study. I have seen living examples of what appear to be *laterale* collected at Seekonk, Massachusetts, near Narragansett Bay and have seen preserved *jeffersonianum* from Long Meadow, Massachusetts, in the Connecticut River valley. Thus the two species here do not necessarily have the same geographic relationship to one another that obtains in the western part of their range. It is possible both forms invaded the New England region after differentiation. Most of Bishop's (1941) New York records seem to refer to *jeffersonianum*, which I have seen from the vicinity of Ithaca. The status of his small, dark form from western New York is uncertain. The specimen he figures (Figure 18d) is not a typical *laterale*, but appears quite similar to the hybrid female form. The abnormal sex ratios reported by Bishop from western New York indicate that he may have observed the "Clanton effect" in an area where the normal population was predominantly *jeffersonianum*, whereas at Ann Arbor, where Clanton's observations were made, the normal population was predominantly *laterale*.

Preserved specimens of *laterale* have been examined from northern Illinois (Winnebago, Lake, and Cook Counties), southeastern Wisconsin,

and southern Michigan. The measurements of Minnesota specimens given by Breckenridge (1944) indicate that *laterale* is the species found in that state, and the specimen he figures is typical. In Canada, *laterale* is probably the more widespread species, however I have examined preserved *jeffersonianum* from the vicinity of Toronto, Ontario. The range of *jeffersonianum* probably does not extend west of the Wabash valley in Indiana. Records for West Virginia (Wilson and Friddle, 1950) and for Venango County, Pennsylvania (Swanson, 1948), probably refer to *jeffersonianum*, and the record from Mammoth Cave, Kentucky (Hibbard, 1936), is almost certainly that species.

ACKNOWLEDGMENTS

Specimens examined during the course of this work were generously made available to me by Dr. H. K. Gloyd of the Chicago Academy of Sciences, Mr. Hyman Marx of the Chicago Natural History Museum, Dr. P. W. Smith of the Illinois Natural History Survey, Dr. Norman Hartweg and Dr. Charles F. Walker of the University of Michigan Museum of Zoology, Dr. Doris Cochran of the United States National Museum, and Dr. James A. Peters of Brown University. Dr. Hobart M. Smith of the University of Illinois has been most generous with encouragement and suggestions. The photographs were taken by Isabelle Hunt Conant of Marleton, New Jersey.

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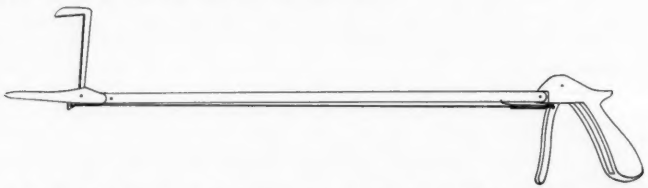
INDIANA UNIVERSITY MEDICAL CENTER,
INDIANAPOLIS, INDIANA

A DEVICE FOR THE COLLECTION OF AMPHIBIANS AND REPTILES.—Tongs and sticks of various design have long been used for the collection of reptiles and amphibians. However, most of these possess certain disadvantages such as excessive weight, two handed manipulation, or a loss of efficiency when collecting conditions vary. The tongs invented by the author and described here, are, by virtue of their light weight and gripping method, positive in action and flexible in use. The improved tongs (see diagram) consist of four major components: handle and trigger, shaft, jaws, and connecting rod.

Handle and trigger: The handle and trigger are cast aluminum. The diagram illustrates their shape and position on the shaft. The handle is recessed and drilled for the reception of the trigger and its pivot. The arrangement of the pivot materially above the axial line of the shaft not only brings the connecting rod close to the shaft for compactness, but provides a greater mechanical advantage when the trigger is pressed.

Shaft: The shaft is a hollow tube of tempered aluminum. It may be obtained in various lengths, depending upon the use to which a particular tongs is put.

Jaws: The jaws are cast aluminum. One is stationary and aligned with the long axis of the shaft. It is composed of two spaced side members connected at their forward extremities by a bar which is of lesser height. The other jaw is movable, actuated by the trigger, and pivoted to work in the slot formed between the sides of the stationary jaw. The movable jaw terminates in a hook.



Connecting rod: The connecting rod is steel. It is through the connecting rod that the force exerted on the trigger is transmitted to the jaw. A spring is attached to the rod and shaft in such a manner that tension is exerted on the rod, and ultimately the trigger and jaw, to maintain the jaws in an open position.

Pressure exerted by the hand on the trigger closes the jaws on the desired object. The smooth, slightly rounded forward end of the stationary jaw facilitates sliding it under the animal. Because of the light weight of the tongs, the efficient handle shape, and the fact that the jaws return automatically to the open position, the tongs require the use of only one hand.

Their use is varied. Though specifically designed for the capture of snakes in both aquatic and terrestial environments, the author has captured birds, frogs, small alligators (up to three and one-half feet), lizards and bats with the tongs.—Lawrence G. Pillstrom, University of Arkansas, Fayetteville, Arkansas.

A New Race of *Urosaurus bicarinatus* (Reptilia: Squamata) from Chiapas, Mexico

By Carlos B. Bumzahem and Hobart M. Smith

Mittleman (Journ. Washington Acad. Sci., 31:72, 1941) mentions two aberrant specimens from Tonalá, Chiapas, ascribed to *U. b. anonymorpha,* which were the basis for extending the range of *anonymorpha* to include Chiapas. He believed at that time that their aberrations tended to remove them from *anonymorpha* but felt that he could not consider them distinct until further specimens were taken from more easterly points in Chiapas. In a collection of amphibians and reptiles from the Región de Soconusco, Chiapas, Mexico, presented to the University of Illinois Museum of Natural History by Mr. Eizi Matuda, are two specimens of *Urosaurus bicarinatus* which appear to support the belief that a distinct race is represented in Chiapas. We wish to thank the United States National Museum for the loan of the Tonalá specimens without which this account could not have been written.

Urosaurus bicarinatus spinosus new subspecies

Holotype. U. S. Nat. Museum No. 113341, adult male, collected at Tonalá, Chiapas, Mexico, by Hobart M. Smith.

Paratypes. U.S.N.M. No. 113342 ♀ from Tonalá, and Univ. Ill. Mus. Nat. Hist. Nos. 34216-7♂ from Región de Soconusco, Chiapas, Mexico.

Diagnosis. A member of the species *Urosaurus bicarinatus* with long belly patches as contrasted with the abbreviated patches of *anonymorpha;* lateral tubercles large, spinose; one or two enlarged scales on posterior surface of each thigh; divided frontal; combined length of enlarged temporal scales about equal to width of ear opening.

Description of Holotype. Frontal broken up into a number of smaller scales; 5 smaller frontonasals forming a row in front of the large median frontonasal; combined length of 2 enlarged temporal scales on each side just anterior to and near upper edge of ear opening about equal to width of ear opening; line of enlarged dorsal scales commencing at level of anterior insertion of forearm and continuing to base of tail; body and neck strongly tuberculate, lateral tubercles large and extremely spinose; femoral pores 11 on each thigh; one enlarged scale on posterior surface of left thigh and two somewhat separated enlarged scales in the same area on the right thigh. Coloration (in alcohol): dorsum of head, body and tail grayish with six dark crossbars on the back, somewhat obscure posteriorly; venter varying from light gray to white; long dark belly patches; tail ringed with darker pigment; chin not ho heavily maculated as in *bicarinatus,* resembling *anonymorpha;* snout-vent length 53 mm; tip of snout to posterior edge of ear opening, 13 mm; tail 80 mm.

Variation. UIMNH 34216-7 are males, while the other Tonalá specimen, USNM 113342, is a female. All three paratypes have a normal but divided frontal in contrast with the holotype; the paratypes have the frontal separated from the large median frontonasal by a small scale, whereas this cannot be ascertained in the holotype due to the condition of the frontal. None of the paratypes are as rugose as the holotype but

are more rugose than typical *anonymorpha* except perhaps USNM 113342 which has tubercles only slightly more spinose. Femoral pores 10-10, 11-10, 12-12; the Soconusco specimens are discolored and black, but the Tonalá paratype resembles the holotype in coloration (in alcohol). Measurements of the paratypes are: UIMNH 34216, 44 mm. snout to vent, head length 11 mm, tail length 61 mm; UIMNH 34217, snout to vent 49 mm, head length 12 mm, tail length 49 mm (incomplete); USNM 113342, snout-vent 44 mm, head length 11 mm., tail length 12 mm (incomplete).

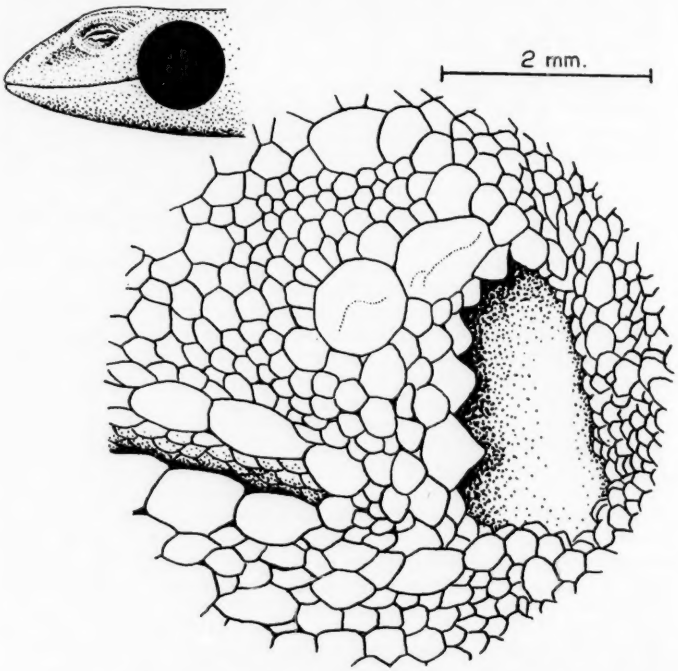


Fig. 1. Section of scales about tympanum, from holotype of *U. b. spinosus*, USNM 113341. Insert indicates area depicted in enlarged view.

Remarks. Fifteen specimens of *anonymorpha* were available for comparison. All three paratypes have a divided frontal, as compared with one out of fifteen exhibiting this character in the other subspecies; all four *spinosus* possess one or two enlarged thigh scales, whereas two *anonymorpha* possess them; combined length of enlarged temporal scales of all *spinosus* is about equal to width of ear opening whereas the scales are equal to about one-half to two-thirds width of ear opening in all fifteen

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anonymorpha; the three ♂ of *spinosus* are definitely more rugose than any of the *anonymorpha;* all three male *spinosus* have long belly patches, but only one of the other subspecies has the venter with a large dark area.

U. b. spinosus represents the species in the Tapachulan province, which merges with the Tehuantepecan province in eastern Oaxaca. In this whole province the only recorded specimens are those here reported. A considerable degree of faunal distinctness is evident in comparison of these two areas; very few species occur in both provinces without subspecific differentiation, and there are numerous species and genera found in one and not in the other. The distinctive features of *U. b. spinosus* seem to be fairly well marked, as subspecies in this genus go, but we regard them as significant wholly because of the zoogeographic correlation.

The range of this race, known to embrace the Soconusco area, is to be expected to reach western Guatemala, along with most other members of the Tapachulan faunal assemblage. Intergradation with *U. b. anonymorpha* probably occurs not far west of Tonalá. As a matter of fact, the smaller Tonalá specimen suggests that even in this area the influence of *U. b. anonymorpha* may be evident. Had the Soconusco specimens been in better condition we would have selected one of them as onomatophore, since the Soconusco area should be entirely free of the influence of *U. b. anonymorpha.*

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THE JUMPING POWERS OF FROGS.—The jumping ability of frogs is given considerable publicity by the annual "Frogolympic" held in Calaveras County, California. The latest record for three successive leaps stands at 16 ft., 2 in., and was attained by a specimen of *Rana catesbeiana.*

It has long been my contention that some of our South African frogs could greatly exceed this distance (Rose, 1950, The reptiles and amphibians of Southern Africa, Cape Town, pp. 16, 17, 43, 366), and I have lately helped to promote a public contest. On Green Point Common, Cape Town, on 16 January 1954, the single specimen of *Rana oxyrhynchus* entered in the contest achieved 24 ft., 4 in., and later improved this to 32 ft., 3 in. This is practically double the longest three jump distance previously recorded. The specimen involved was an adult male, measuring 55mm. snout to vent, from Durban, Natal, and was tested straight from its traveling box without any practice. The leaps were purposely directed against what wind there was. The other competitors, *Rana fuscigula,* in some cases just exceeded 9 ft., 5 in.

This phenomenal jumping ability probably has some selective value and may be relative to the numbers and speed of the frog-eating snakes occurring in Natal (*Chlorophis* and *Philothamnus*).—Walter Rose, "Oaknook," Protea Road, Newlands, C. P., South Africa.

SOME NOTES ON THE FEEDING HABITS OF SNAKES.—The specialized egg-eating technique of the African snake *Dasypeltis scabra* is well known, as is the fact that other snakes such as cobras and mole snakes in Africa, and the king snake in America, swallow eggs whole, leaving the digestive fluids to cope with the shell. The Cape Argus (12 Jannuary 1954) published a report of two Ringhals, *Haemachates hemachates,* that had made noticeable depredations on a poultry yard.

For many months one of my sons has kept Mole snakes (*Pseudaspis cana*) and has fed them exclusively on the eggs of pigeons, bantams and pullets. The larger one (total length 56 in.) of these specimens has the usual habit of swallowing the egg entire and digesting the unbroken shell. The smaller one (total length 51 in.), has, however, demonstrated a technique previously unknown to me. Taking the egg in the usual way, the snake would make a writhing movement with its neck once the egg was fairly well into the throat, thus breaking the egg with an audible crack and then swallowing shell and all. This may offer a suggestion regarding the primary origin of the egg-cracking method used by *Dasypeltis.*

Mole snakes also readily devour the eggs of cobras, and may form a useful check on their increase, as indicated by a number of observations to this effect.

I have stated elsewhere (The reptiles and amphibians of Southern Africa, Cape Town, 1950, p. 258) that *Dasypeltis* will take partly incubated eggs, and will even take, crack and reject addled eggs. More recent observations include the taking by a young *Dasypeltis* of the egg of a small bird in which the chick was well advanced, and by a larger specimen of an egg of the tortoise, *Chersine angulata.* In the former case the chick was ejected with the shell, in the latter the shell was ejected as a shapeless mass.

Several instances have come to notice of snakes eating the putrid bodies of other snakes. In one case a Boomslang, *Dispholidus typus,* was encountered devouring the corpse of another specimen of the same species, from which maggots were dropping (Rose, 1929, Veld & Vlei, Cape Town, p. 223), and in several others, Cobras, *Naja nivea,* ate the decomposing bodies of Puff Adders, *Bitis arietans,* that had been partly digested and then vomited by other Cobras. Boulenger (The snakes of Europe, London, 1913, p. 97) also mentioned vipers, *Vipera berus,* having been observed to eat voles showing signs of putrefaction.

It thus appears that snakes are not such dainty feeders as had been supposed. This may to some extent apply to lizards as well, as I have seen *Cordylus cataphractus* devour a decomposing *Acontias meleagris* (Rose, 1929, *ibid.,* p. 218), and Cowles (Jour. Entom., Vol. 22, No. 1, p. 7) reports finding a maggot-filled mouse and other decaying rodents in the stomachs of *Varanus niloticus.*—Walter Rose, "Oaknook," Protea Road, Newlands, C. P., South Africa.

A New Lizard (Genus *Eumeces*) from Arizona

By CHARLES H. LOWE, JR., *and* F. A. SHANNON

In their study of western skinks of the *skiltonianus* group, Rodgers and Fitch (1947) point to the fact that *Eumeces gilberti rubricaudatus* differs morphologically in each of the major portions of its range. The distribution significantly includes a completely disjunct population in Arizona. At the time of their investigation, Rodgers and Fitch found no fresh material or young specimens available to enable them to make a critical study of the Arizona population. We have recently collected and studied fresh specimens, both young and adult, from five miles southeast of Wickenburg, Maricopa County, Arizona. Through examination of this material, we confirm the opinion of Rodgers and Fitch that the disjunct Arizona population of *Eumeces gilberti* is distinctive. We accordingly describe it here as a new subspecies.

Eumeces gilberti arizonensis subsp. nov.

Holotype. Number 3218 in the herpetological collection of F. A. Shannon (FAS), Wickenburg, Arizona. Collected July 8, 1953, at 5 mi. SE Wickenburg, Hassayampa River, Maricopa County, Arizona, by Richard W. Abbuhl. Preserved in alcohol July 10, 1953.

Diagnosis. Characterized by (1) small size; (2) 58-60 (59±.40) scales from occiput to base of tail; (3) partial retention of juvenile characters in adults; (4) a dark lateral line located on the fourth and fifth scale rows below the dorsal midline of adults and extending from the head to the insertion of the hind limb; (5) adult coloration of head light orange brown; (6) tail color of young pale yellow above, pinkish below (probably pink in hatchlings); (7) a transverse dark bar on each scale of the two mid-dorsal rows covering *two-thirds or more* of the exposed scale surface, thus leaving a narrow light band at the anterior edge of the scale; (8) dorsolateral light stripes 1.5 to 2 scales wide on the posterior third of the body.

Description of holotype (measurements and colors from the freshly killed specimen). Adult female with a snout-vent length of 80.1 mm.; tail length 147 mm.; head width, 10 mm.; head length to tip of interparietal, 12.5 mm.; right hind leg, 29.4 mm. to base of fourth toe nail. Supralabials 8-8; nostril occupying posterior 2/3 of nasal; postnasal slightly larger than nostril; two loreals, the posterior twice as big as anterior; anterior three superciliaries considerably enlarged; preocular tiny, transversely elongate and in line with upper ciliary series; two anterior suboculars; two posterior suboculars; one postocular; one primary temporal nestled between seventh and eighth supralabials; two large secondary temporals; a tertiary temporal adjacent to lower secondary; four large supraoculars followed by a fifth small scale intermediate between fourth supraocular and postocular; first three supraoculars contacting frontal, third and fourth contacting frontoparietals, fourth contacting parietals; frontoparietals in contact medially; interparietal not enclosed by parietals, tending to be wedge-shaped rather than parallel-sided, pointed at apex; two small postlabials following enlarged eighth labial, separated from auricular opening by three tiny preauricular scales on left and four on right; two pairs of nuchals. Mental followed by two postmentals, the

posterior being two to three times size of anterior; three large chin shields on each side. The postgenial series cannot be differentiated from the gulars. Sixty dorsal scales are present from the occiput to the base of the tail; 24 scales around the midbody; four scales are overlapped by the adpressed limbs.

The upper surfaces of the body, tail, and legs are light olive brown; upper surfaces of head pale orange brown; ventral surface of head immaculate cream color with a faint tinge of orange; labials pale orange; ventral surfaces of body and legs cream colored, with a greenish-blue tinge. A weak melanophore stippling is present on belly scales, absent from ventral scales of chin, neck, and legs, and mid-ventral portion of tail. Posterior third of tail pale yellowish on all surfaces. Tip of tail (4 mm.) pale pinkish.

There is a dark lateral stripe on body and neck extending from over the ear to the hind leg. It is consistently placed on the fourth and fifth scale rows lateral to the dorsal midline. Lateral and dorsolateral light stripes are especially conspicuous on the anterior part of body, neck, and head where they continue to the rostral. The lateral stripe is white on the neck and dull orange on the side of the head where it passes over the labials to the tip of the snout. The dorsolateral stripe is pale orange on the head, grayish-green on the nape and neck, and gradually changes posteriorly to light olive brown. As the specimen is adult, the color pattern represents retention, in reduced intensity, of juvenile characteristics.

Material. In addition to the type, three paratypes are present as follows: FAS Nos. 1648 and 3219 from 5 mi. SE Wickenburg, and University of Arizona, Department of Zoology No. 664 from 1.5 mi. SE Wickenburg, Maricopa County, Arizona.

Variation and ontogenetic change. The supralabials are 8-8, the nuchals two pairs in all. The largest specimen in the series is a male with a snout-vent measurement of 81.5 mm. None of these lizards has the interparietal scale enclosed by the parietals. Number of scales from occiput to base of tail for the series is $59.0 \pm .40$ (58-60). This is below the mean for *E. g. rubricaudatus* ($61.1 \pm .15$) and is at the extreme lower end of the curve of variation in *rubricaudatus* (inclusive of *arizonensis*) as given by Rodgers and Fitch (*op. cit.*). The difference is significant with $t = 3.9$ and P less than .01, using the small sample formula of Simpson and Roe (1939).

It is important to note that adults of *E. g. arizonensis* partially retain their juvenile pattern to snout-vent lengths of at least 80-85 mm. The most conspicuous retentions are (1) the dark lateral stripe from over the ear to the hind limb insertion, and (2) the lateral and dorsolateral light stripes on the anterior part of body, neck, and head. This may be contrasted with the statement of Rodgers and Fitch (*op. cit.*, p. 204) that the juvenile pattern is usually completely lost in *E. g. rubricaudatus* at a snout-vent length of 60-70 mm.

Ontogenetic color pattern changes in *E. g. arizonensis* follow those for all races of *E. gilberti*. The following description is that of a fresh young male specimen of *arizonensis*, 55.3 mm. from snout to vent (FAS No. 3219). The tail is pale yellow above and pale pinkish below. The

dorsolateral and lateral light stripes are well defined, extending forward to the rostral. The dorsolateral stripe is tinged with orange on the head and neck and cream color on the body. It is wide and encompasses 1.5 to 2 scale rows (the second and third) on the posterior body third. The lateral light stripe (on the sixth and seventh scale rows) is cream colored on the body, and tinged with orange on the side of the head and along the labials. The mid-dorsal dark field of two scale rows is dark brown, sharply margined with black. Each scale of the two mid-dorsal rows has a light band anteriorly (rather than a dark band posteriorly as in *E. g. rubricaudatus*); thus the major portion of each scale in *E. g. arizonensis* is dark colored rather than light colored as in other races of *E. gilberti*. The snout and chin are tinged with faint orange.

Distribution. E. g. arizonensis is known from Yavapai (Prescott, Yarnell, 5 mi. N Wickenburg) and Maricopa (1.5 mi. SE Wickenburg, 5 mi. SE Wickenburg) counties, Arizona.

Ecology. The collecting site at the type locality is in a short (175 yds. long), narrow, steep-sided box canyon (or arroyo) joining the west side of the Hassayampa River. The immediate habitat is Riparian Woodland with cottonwood (*Populus fremonti*), mesquite (*Prosopis juliflora*), hackberry (*Celtis reticulata*), catclaw (*Acacia greggi*), and elderberry (*Sambucus*) forming the major portion of the canopy. Skinks have been found along the bases of the steep arroyo walls, in good leaf litter on the well-shaded, sandy floor.

The adjacent and surrounding hillsides support a rich Paloverde—Sahuaro—Cholla vegetation type with much jojoba (*Simmondsia chinensis*) and brittle-bush (*Encelia farinosa*). This desert climax of the Arizona upland section of the Sonoran Desert borders the Hassayampa River on both sides in the vicinity of Wickenburg. In this area, the Hassayampa River bottom supports a riparian community of large cottonwood, willow, and mesquite trees. *Eumeces gilberti* in the Wickenburg area of Maricopa and Yavapai counties is restricted to the general vicinity of the Hassayampa River and the riparian communities to be found there. In the higher elevated vicinity of Yarnell, Yavapai County, a second major ecological area where *Eumeces g. arizonensis* has been taken, the general vegetation type is Chaparral with a strong component of oak (mainly *Quercus turbinella*). In the vicinity of Prescott, a third area of still greater elevation where *arizonensis* has been recorded, the vegetation is Pinyon-Juniper Woodland and Yellow Pine Forest. The Hassayampa River drainage system cuts through these higher zones of vegetation as it courses southward into the desert. It is noteworthy that corresponding Chaparral and Oak Woodland habitats are characteristically occupied by the closely allied *E. g. rubricaudatus* which also occupies desert border habitats in California. Thus it appears that *E. g. arizonensis* enters the desert along drainageways from the more mesic habitats of higher elevations, as does *E. g. rubricaudatus* in California.

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A POSSIBLE RANGE EXTENSION FOR *NATRIX GRAHAMI*.—United States highway number 84 crosses on a levee a small artificial lake in the southern edge of Post, Garza County, Texas. This levee, not more than 100 yards in length and which divides the lake into two parts, has proved to be a death trap for a great many reptiles and amphibians. On July 31, 1954, the writer found a freshly killed gravid female *Natrix grahami* (Baird and Girard) lying on the highway at the crossing. This was a particularly large individual, measuring 35¾ inches in total length before being preserved. Scale counts were as follows: upper labials 7-7, lower labials 10-10, preoculars 2-2, postoculars 2-2, anterior temporals 1-1, ventrals 165, caudals 52, dorsal scales 20-19-17. Dissection revealed 31 well formed and almost completely pigmented embryos which probably would have been born in two or three weeks. The stomach contained no food. The specimen and all of the young have been deposited in the collection of Texas Christian University.

Brown (1950) remarks that the distribution of *Natrix grahami* is not clearly defined. The westernmost records he gives are from Tarrant, McLennan, and Bexar Counties in Texas. Last year, Mr. Philip Harter found a *Natrix grahami* about six miles west of Palo Pinto, Texas, and later he and the writer found a second specimen at the same locality. If the specimen from Post, Texas, does indicate a valid range extension, it will extend the range for the species about 175 miles west of the Palo Pinto locality or about 245 miles west of the Tarrant County locality and about 310 miles slightly northwest of the Bexar County locality. The excellent physical condition of the specimen itself would seem to indicate that probably it was not an escapee.

Post, and in fact all of Garza County, Texas, lies within the drainage area of the Brazos River system. Similarly, Palo Pinto County drains into the Brazos. It does not seem improbable that *Natrix grahami*, known to occur in the Brazos River system at least from Waco to College Station, Texas, has found its way as far upstream as the vicinity of Post, Texas.

The number of young which this specimen contained seems to be rather large. Conant and Bridges (1942) indicate that about ten are born. Schmidt and Davis (1941) indicate that 10 to 15 are born. The number found in this individual may, however, correlate with its extremely large size.

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L. W. RAMSEY, TEXAS CHRISTIAN UNIVERSITY, FORT WORTH, TEXAS

A New Subspecies of the Lizard *Sceloporus clarki* from the Colorado Plateau of Arizona

By F. A. SHANNON *and* R. F. URBANO

On the afternoon of August 23, 1953, two specimens of *Sceloporus clarki* were taken at Granite Dells, Arizona, by R. F. Urbano and F. A. Shannon. Granite Dells is located at an altitude of about 5,000 feet, five miles north of Prescott at the junction of highways 89 and 89A. The surrounding terrain is composed largely of granitic boulders, with a scattered oak-juniper cover. A third specimen was taken from a granite boulder at nearby Lake Watson. Realizing that the specimens represented an undescribed subspecies, a return trip was made the following day by Mr. Urbano and Richard Abbuhl to Granite Dells, where four additional specimens were obtained. Another Granite Dells specimen was loaned to us by Dr. Charles Lowe, Jr., from the collection of the University of Arizona. These eight lizards form the type series for the description of

*Sceloporus clarki vallaris** subsp. nov.

*The name means "of or relating to the vallum," *i.e.*, a rampart, mound, or wall.

Holotype (fig. 1). From the private collection of F. A. Shannon; FAS 3997, an adult male from Granite Dells, four miles north of Prescott, Yavapai County, Arizona. Collected by R. F. Urbano and Richard Abbuhl on August 24, 1953.

Paratypes. FAS 3976 ♀, from edge of Lake Watson, four miles north of Prescott, August 23, 1953; FAS 3992 ♂, Granite Dells, August 23, 1953; FAS 3998 ♀ and 3999 ♂, Granite Dells, August 24, 1953; FAS 6094 ♀, Granite Dells, August 24, 1953; Univ. Illinois Museum Nat. Hist. 34,780 ♀, Granite Dells, August 23, 1953; Univ. Arizona 674 ♂, Granite (Dells) Creek, four miles north of Prescott.

Diagnosis. The lizard is characterized by: (1) retention of juvenile color pattern in even the largest males; (2) first infralabial completely separated from postmentals by contact of sublabials with the mental; (3) tendency toward increase in number of dorsal head scales by a plastic inclination to split off new scales from others well established in the species.

Description of holotype. A large male, measuring 224 mm. in total length; body length, 108 mm.; head length, 21.4 mm.; head width, 25.2 mm. Scales around middle of body, 37; 32 dorsal rows of scales from occiput to base of tail; 5-5 supraoculars in contact posteriorly with lateral parietals and posterior portions of frontoparietals; supraoculars separated from medial head scales over two-thirds of their anterior length by a fine row of circumorbitals; a small intermediate frontoparietal formed by separation of rear acuminate tip of posterior frontal; a small intermediate prefrontal present (probably formed from median frontonasal); three auricular scales on each side; first postmental separated from infralabials on each side by first row of sublabials which contacts the mental; two pairs of internasals; three frontonasals, middle largest; two rows of strongly keeled lorilabials beneath subocular; loreal single and not large.

Dorsal scales strongly keeled; lateral scales weakly keeled; no evidence of keeling on ventral scales, except in gular region. Femoral pores 13-12

in number; seven scale rows between femoral pore series; base of tail broad, flattened, wider than high; tail rounded and strongly keeled.

Dorsal color pattern consists of four irregular black body bands on a brown ground color. These bands are bordered posteriorly with light, erratically situated cyanide blue or straw-colored marks. There is a band across supraocular region and faint evidence of a black transverse band just behind the parietals. Twelve moderately distinct transverse bands are present on the dorsum of the tail; antebrachium banded in characteristic style of *S. clarki;* two faint bands present on brachium; femoral and tibial surfaces distinctly banded.

The venter is a pale straw color, marked in the gular region by a large, cyanide blue spot which is in turn irregularly bordered with mottled grey. There are two large bluish abdominal marks, likewise irregularly bordered with dark and separated medially by a narrow stripe of the ground color. The ventrum of the tail is immaculate.

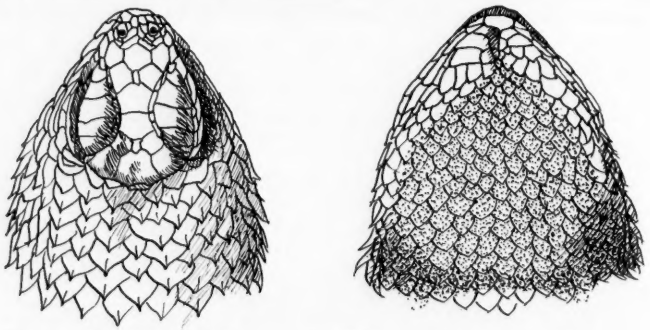

Fig. 1. Holotype of *Sceloporus c. vallaris.*
1a. Dorsal view of head.
1b. Ventral view of head; stippling shows extent of blue gular patch.

Remarks. The most remarkable feature of this Colorado Plateau subspecies is retention of the color pattern even in the largest adult males. Little evidence of the dorsal color pattern may be found in male *S. c. clarki* with a body length greater than 80 mm., or in females larger than 85 mm. The color pattern in individuals from the Plateau of a comparable length is brilliant. This brilliance is not solely a matter of a more distinct color pattern, as the over-all appearance is that of a bluer lizard, due to the presence of many more cyanide-blue scales on the dorsum. Likewise, the gular region of large male *vallaris* is cyanide-blue, bordered with dark, whereas the comparable region in *S. c. clarki* is dark blue or grey-black, bordered with black. Females of both subspecies have dark-lined gular regions.

Specimens of *vallaris* are similar to those of *Sceloporus magister* in having the postmental separated from the infralabials by contact of the first row of sublabials with the mental. This contact is present in six

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(75%) of the eight specimens. Of the two specimens lacking such contact, there is near contact on the right side of FAS No. 3992. One of the six (UA No. 674) has no contact on the left side. In a series of 177 specimens of *S. c. clarkii* recorded by Dr. Hobart Smith (1939, The Mexican and Central American lizards of the genus *Sceloporus*. Field Mus. Nat. Hist., Zool. Ser., 26: 124), only 8, or 4.5%, had any contact of the sublabials with the mentals. Two of the eight (25%) *vallaris* have an azygous scale between the prefrontals, whereas only seven of 72 specimens of *clarki* listed by Smith (*loc. cit.*: 124) (9.7%) have a similar scale. An azygous separates the frontal from the interparietal in 50% of the *vallaris* but is present in only 25% (18 of 72) of *clarki* specimens (Smith, *loc. cit.*).

Sceloporus clarki is not the only species of Arizona fence lizard to have a Plateau population demonstrating a trend toward an increase in the number of dorsal head scales. A similarly located population of *Sceloporus magister* (data as yet unpublished) shows a statistically significant increase in such head scales.

WICKENBURG, ARIZONA

Distributional Records for Two Species of *Plethodon* in the Southern Appalachians

By RICHARD L. HOFFMAN *and* LESLIE HUBRICHT

The following information concerning the distribution of two eastern salamanders of the genus *Plethodon* is derived from specimens picked up by the authors mostly incidental to the collection of material in other animal groups. We feel that presentation of these data will be a matter of some interest to herpetologists interested in the Plethodontidae, as they involve new state records for one species and a considerable extension of the known range of another into a physiographic province from which it has hitherto not been known. Perhaps one of the most pertinent aspects of this new information is the re-emphasis of the fact that still very little it known about the distribution of salamanders in eastern United States despite much recent field work by numerous herpetologists. We suspect that too much has been done in the way of repeated collecting at type localities and at oft-plundered (easily accessible) places such as Grandfather and White Top mountains, and not enough exploratory work off the beaten track at lower elevations in the Southern Blue Ridge and adjacent regions.

The North Carolina specimens reported on herein were obtained by Hubricht, those from Virginia localities by Hoffman. All will be deposited in the collection of the U.S. National Museum.

Plethodon richmondi Netting and Mittleman

This elongated relative of *Plethodon cinereus* has been recorded from Kentucky, West Virginia, Ohio, and Pennsylvania, and recently from several counties in western Virginia by Grobman (1949, Proc. Biol. Soc. Washington, 63: 135). We feel that these Virginia records do not apply to typical specimens of *richmondi* (cf. commentary below).

The following records are of interest in constituting a considerable extension to the southeast of the presently known range of *richmondi*, as

well as in adding another species to the herpesian faunas of both Virginia and North Carolina.

VIRGINIA—*Tazewell Co.:* Burkes Garden, 3200 ft., March 20, 1954 (18 specimens); Garden Mountain, 3800 ft., March 30, 1954 (4 specimens). *Wythe Co.:* 6 miles west of Wytheville, *ca.* 2500 ft., March 30, 1954 (4 specimens).

NORTH CAROLINA—*Alleghany Co.:* ravine at milepost 236 on the Blue Ridge Parkway, October 10, 1953 (1 specimen); upland oak woods, 2900 ft., 2 miles southwest of Sparta, October 17, 1953 (1 specimen). *Ashe Co.:* near fire tower on Nigger Mountain, 4500 ft., October 17, 1953 (1 specimen).

Data have been taken on 20 of the specimens at hand (17 from Virginia, 3 from North Carolina). In this series, the costal grooves range from 19 to 22 (avg. 20.2), intercostal folds between appressed toes from 8 to 11 (avg. 9.5), and vomerine teeth from 8 to 16 (avg. 10.2). These characters fall within the known range of variability of *richmondi,* and a further confirmation of the identity of our specimens was made possible by the generous cooperation of Dr. N. Bayard Green, who provided a series of living topotypes of *richmondi.* There is complete accord in all qualitative features between our specimens and those sent by Dr. Green.

P. richmondi was initially recorded from Virginia by a spot on the distribution map in Dr. Grobman's paper on the distribution of eastern species of *Plethodon.* This spot was based upon a specimen in the Carnegie Museum (No. 18449) collected at Blacksburg, in Montgomery County. After several years of collecting at Blacksburg without finding additional specimens of *richmondi,* Walter B. Newman borrowed the specimen in question and found it to be a dark-back phase *P. cinereus.* Several additional seasons of field work around Blacksburg by Hoffman serve to corroborate this discovery, *viz.*, that *richmondi* does not occur in Montgomery Co., Virginia, although dark-back specimens of *cinereus* are not rare. These specimens are metallic in life, and since there is some overlap in costal groove count in *cinereus* and *richmondi,* a misidentification is easy to understand. The most useful means of discriminating between the two is the uniformly dark throat and venter of *richmondi* as contrasted to the mottled, "salt-and-pepper" effect characteristic of *cinereus.*

The more recent records of Grobman for Alleghany, Bath, Craig, and Rockbridge counties, Virginia, are definitely not founded upon specimens of *cinereus,* but, with the examination of Dr. Green's series of *richmondi* from the type locality, it becomes apparent that they apply to a different and unnamed form which differs from *richmondi* in various respects involving color and structural features. The status of these so-called *richmondi* salamanders is still unsettled, although Mr. M. Graham Netting has had the matter under investigation for many years. For this reason, we preclude any detailed discussion at this time.

It may be of interest to note that *richmondi* is very abundant at Burkes Garden during March, and on one occasion a series of 18 specimens was assembled in less than an hour of collecting. During that time, at least a dozen additional specimens were discovered but not retained. Ten days

later, *richmondi* was again found in large numbers at a nearby locality, but only a few were collected. The animals were particularly abundant in a nearly cleared pasture, under logs and split fence rails, but not under flat stones. A large female was examined for stomach contents; these included half of a centiped (*Scolopocryptops sexspinosus*) which would have been about 30 mm. long when intact; a larva of an elaterid beetle about 15 mm. in length; and about 60 termites.

Plethodon jordani melaventris Pope and Hairston

This black-bellied race of *P. jordani* occupies the southern part of the Blue Ridge Province southeast of the Swannanoa River and south and west of the Balsam Mountains. Although it has been found as low as 2000 feet in the gorge of the Whitewater River (in Oconee Co., S.C.), *melaventris* has not heretofore been discovered away from the main *massif* of the Blue Ridge in the broad sense. The following new locality for this form is noteworthy in extending the range some 35 miles to the northeast, into a different physiographic province, and to perhaps a new low in the vertical distribution of the salamander.

On September 4, 1953, a small specimen of *melaventris* was collected on Burkemont Mountain, about 6 miles south of Morganton, Burke County, North Carolina. This animal was found in the woods near the road which ascends the north side of the mountain, at an elevation of 1900 feet. Later, on September 25, this site was re-visited and three very large adult specimens were obtained.

Burkemont Mountain is one of a number of low peaks in the South Mountains, a range of Blue Ridge outliers in the Piedmont of western North Carolina, chiefly in Burke and Rutherford counties. The highest peak, Walker Knob, rises to an elevation of 2919 feet. The South Mountains are entirely separated from the Blue Ridge by the broad flat valley of the Catawba River, and the population of *melaventris* inhabiting them is, ecologically speaking, truly insular. But comparison of our material with topotypes of *melaventris* from Highlands, North Carolina, reveals no differences and apparently no differentiation of the South Mountain stock has yet taken place.

In addition to the locality noted above, it may be mentioned that during the Fall of 1952, another specimen was seen but not collected near the church on Walker Knob.

The specimens at hand are exceptionally large, and appear to exceed previous records for any member of the Jordani Group. The male measures 82 mm. from snout to anterior angle of vent, with a total length of 175 mm. The larger of the two females is 80 mm. in body length, and 173 mm. overall.

The discovery of a member of this group of *Plethodon* at such an unlikely place suggests that further reconnaisance at peripheral localities may be of interest and profit. A continuation of the South Mountains north of the Catawba River, known as the Brushy Mountains, is one such possibility.

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Two Family-Groups[1] of Neotropical Frogs

By W. Leslie Burger

Two recent herpetological papers (Savage and Carvalho, 1953; Vellard, 1951) deviate sufficiently from recommended nomenclatural practice to deserve special attention. In addition, the purely biological aspects of the two papers invite comment, which can be conveniently presented here, as both works treat the same general group of neotropical frogs.

The authors of both papers designate the names of the family groups as "new," whereas actually the same two names, with slightly different endings, were proposed for these groups more than a century ago. Although the present International Code of Zoological Nomenclature does not provide for priority of family-group names, such priority is implicit in Opinion 14 of the International Commission of Zoological Nomenclature and is the custom. Moreover, it is customary to treat family and subfamily names as co-ordinate with one another for purposes of priority; a name published for a unit of any category in the family-group retains its priority even if that unit is subsequently treated as belonging to a different category in the family-group. Fortunately, these subjects are treated in the decisions on nomenclature of the recent Congress of Zoology at Copenhagen (Hemming, 1953: 32-37) and presumably will be added to the revised Code. The published decisions of the 1953 congress were not, of course, available to any of the authors mentioned above.

The family-groups involved are as follows.

Pseudinae

The name Pseudidae, used by Savage and Carvalho (1953:198) for a "New Family" comprising *Pseudis* Wagler and *Lysapsus* Cope, was actually first proposed by Fitzinger (1843: 33). The last mentioned author used a shorter termination to form Pseudae and included *Brachycephalus* in the family; but neither consideration affects its validity because *Pseudis* obviously is the type.

Savage and Carvalho's paper contains excellent discussions and diagnoses of the two genera (*Lysapsus* is resurrected) and of the five species. However, their conclusion that the two genera comprise a distinct family calls for careful consideration. According to them, the characteristics that eliminate *Pseudis* and *Lysapsus* from the Hylidae are (1) presence of an accessory phalanx and (2) cylindrical sacral-diapophyses. Of these features, the first is emphasized by the above named authors because the second feature is duplicated in a number of hylids. The importance of the first feature, the accessory phalanx, hinges on its interpretation. This phalanx may be homologous to the hylid intercalary cartilage, as Parker (1931: 494; 1935: 511) suggested, rather than analogous to it, as stated by Savage and Carvalho. *Lysapsus*, with its accessory phalanges of moderate size and intermediate position, and its small toes, seems to be an ideal link between *Pseudis* and typical hylids (see Savage and Carvalho, fig. 5).

[1]The Colloquium on Zoological Nomenclature at Copenhagen (Hemming, 1953 : 32) recommended that the expression "family-group" be used to denote all those categories between genera and orders.

(Certain hylids, like *Acris*, that diverge from the typical tree frog habit show a similar elongation of intercalary cartilages.) The interesting information presented in the recent paper (conclusions there to the contrary) seems to verify Parker's decision (1935: 511) that the Pseudinae is best considered a subfamily of the Hylidae.

Several other characters not mentioned, or at least not emphasized by Savage and Carvalho, seem to deserve consideration:

(1) *Opposable first fingers*, such as occur in these frogs, are otherwise recorded in neotropical frogs only in the Hylidae and Centrolenidae. The first finger is also opposable in certain Australian leptodactylids of the genus *Cyclorana*.

(2) *Giant tadpoles*, like those of *Pseudis*, are to be noted in a number of frogs that are aquatic as adults. In all of these cases the increase in tadpole size definitely seems to be a specialization.

(3) The *moderate-sized pads* on the developing hind limbs of advanced tadpoles of *Pseudis* (these pads are reduced in later development) may have recapitulatory significance.

(4) The *vocal sacs* of *Pseudis* are paired, external, and subgular, according to Liu (1935: 26, 33). Paired subgular vocal sacs occur in certain species of the Leptodactylidae and the Hylidae, although median subgular sacs are much more frequent in both families. Therefore, this feature does not seem to especially favor affinity of *Pseudis* with one or the other family. Liu tentatively concluded that paired and external conditions of the vocal sac are derived from median and internal conditions, respectively. In both respects the vocal sac of *Pseudis* is specialized.

The second and fourth feature listed above and the dilated sacral diapophyses of *Pseudis* suggest that the genus is highly specialized. The first and third feature and the elongate intercalary cartilage strongly (although possibly not conclusively) point to tree frogs as the immediate ancestors of *Pseudis* and *Lysapsus*. Having observed the remarkable *Pseudis paradoxus* in its natural habitat, I would doubt that it is related to tree frogs, *were it not* for the connecting link, *Lysapsus*. Indeed, *Lysapsus* may be very near the direct line of descent of *Pseudis* from some hylid. In this connection, the tadpole of *Lysapsus* (especially its size and the development of toe pads on the hind legs before metamorphosis) may furnish critical evidence.

Probably nothing short of comprehensive revision of the neotropical Hylidae and possibly the Leptodactylidae—other genera of aquatic "leptodactylids" (see below) may also be involved—will fully clarify the situation. In any case, elevating the Pseudinae *sensu stricto* to full family rank at this time, when they (especially *Lysapsus*) are but poorly distinguished from the Hylidae, does not seem justified.

Telmatobiinae

A similar case is presented by the above name proposed by Vellard (1951: 21) for a new subfamily ("Subf. nov.") of the Leptodactylidae. Fitzinger (1843: 32) proposed the family Telmatobii for *Telmatobius* Wiegmann; therefore, the recent description is in no sense *new*.

Vellard presents a wealth of interesting ecological and variational data for Peruvian species and subspecies of *Telmatobius*, but does not

compare them with likely generic relatives other than the Peruvian *Batrachophrynus* Peters. Noble (1931: 499) includes *Pseudis, Cycloramphus* Tschudi, *Grypiscus* Cope, and *Calyptocephalus* Duméril, Bibron, and Duméril in the aquatic group of Pseudinae. (With the transference of *Pseudis* to the Hylidae, the subfamily takes the next available name, Ceratophryinae, according to Parker.) Any or all of the remaining genera listed above may be closely allied to *Telmatobius* and *Batrachophrynus*.

Summary

Pseudinae Fitzinger (not Savage and Carvalho) seems to be a subfamily of the Hylidae. Of the two genera that comprise it, *Lysapsus* is probably ancestral to *Pseudis*. Telmatobiinae Fitzinger (not Vellard) may be a valid subfamily of the Leptodactylidae; if so, the limits of this subfamily require clarification.

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Natural History Notes on the Barking Frog

By WAYNE MCALISTER

Several brief notes are to be found in the literature on the natural history of the barking frog (*Eleutherodactylus latrans*). However, few of these do more than briefly mention that this species inhabits caves as well as limestone outcroppings and cliffs. Nine specimens of the barking frog were collected in Mural Cave, Travis County, Texas, on May 8 and 10, 1954, including two gravid females. Notes were taken immediately after each descent and are given below in a slightly altered form.

Mural Cave lies almost on the dividing line between Travis and Williamson Counties and approximately one mile north of the town of McNeil. The surrounding country is dry, in places overgrown with post oaks and chaparral brush, and studded with limestone outcroppings. The cave is essentially one huge room almost forty feet below the surface of the ground. The walls and ceiling are limestone, and huge stalactites and stalagmites of lime carbonate and sugar crystal (calcite) are abundant. Six side passages lead from the main room, all either eventually returning to the room or tapering to a blind halt. The floor of the room and passages is heavily covered with a rich, damp mixture of earth and bat feces. The walls are pitted with shallow crevices.

Mural Cave was first entered at 9:30 p.m. on May 8. Our party had just reached the main room when a ventriloqual, whirring grunt was heard repeated at regular intervals about two seconds apart for almost thirty seconds. Although this sound soon ceased, it was heard several more times for short periods. This was possibly the call of the barking frog.

The first frog was discovered as it sat motionless on the floor of the main room amidst fallen debris. Its strange appearance, large eyes, and pulsating throat were observed for only a moment before the specimen was grasped. It resisted capture by vigorously struggling to get free, but it uttered no sound. The curiously dry skin was immediately noticed. A diligent search amidst and beneath surrounding debris failed to produce further specimens.

The second frog was discovered when the reddish reflection from its eyes was noted in a wide, low side passage where it was sitting motionless with its back against one wall. No means of escape for the specimen was evident, since the wall crevices were shallow and the passage had a smooth earthen floor lacking any debris. The frog was easily caught with the hand, and it reacted much like the first one had done.

The reddish glow of the third specimen's eyes was discerned around a bend in the passage referred to above, however, further advancement was made impossible by the exceedingly low ceiling. Only after the lapse of almost fifteen minutes was a very small opening found through which the motionless frog could be reached and grasped. The cave was vacated soon after the last capture, at 10:30 p.m.

We again entered Mural Cave at 8:10 p.m. on May 10. No grunt-like calls were heard during the search for specimens. The side passage in which previous specimens had been found was immediately entered,

resulting in two more captures. Both frogs were sitting with their backs to the wall and about three yards apart. The first was easily captured with the hand, but it was necessary to frighten the other before it could be reached. Upon being touched with a stick the specimen gave several short, toad-like hops and stopped. It was then within arm's reach and was easily taken.

The next frog was taken on one of the broken, slippery ledges fifteen feet up on a near-vertical wall in the main room. This specimen was resting on the abdomen with the limbs outspread and had apparently been trying to ascend a small incline of shifting, powdery limestone. The frog's entire body was coated with limestone powder. Only a few feet distant from this specimen was found a very small, shallow puddle of water which contained no visible life.

The next two frogs were discovered at one end of the room about twenty feet above the level of the floor. The first of these was sitting beneath an overhanging rock at the top of a slippery incline and was reached with difficulty. The second specimen was noted only after we had crawled directly over its retreat several times. It sat motionless in a small crevice only about five yards from the other frog. This specimen was easily extracted. A very small, clear puddle of water was discovered near the frogs, but it harbored no life.

The last frog was taken from its position on top of a boulder which lay on the floor of the main room. We vacated Mural Cave at 9:15 p.m.

None of the frogs taken resisted capture other than by struggling steadily at the hand which held them and by considerably puffing up the body. All leaped about wildly for a few moments when first dropped into the collecting jar. In one instance a specimen was taken in close proximity with adult examples of the nebulous toad (*Bufo valliceps*) and of Marnock's frog (*Syrrhophus marnocki*). Including the three species already mentioned, the following animal life was recorded from the cave: slimy salamander (*Plethodon glutinosis albagula*), camel cricket (*Ceuthophilus*), sow bug (*Oniscoida*), scorpion (*Scorpionida*), harvestman spider (*Pholcidae*), earthworm (*Lumbricus?*), and one unidentified species of bat.

Three of the nine frogs collected were given to another student and further observations on these are not available. Three males and three females were retained, and it was unfortunately necessary to preserve all specimens. The two gravid specimens gave no indication of their condition from outward appearance. One contained only very small, immature white eggs which were not closely examined. The other contained seventy-six large eggs which showed no internal development. The average total diameter of each egg is five millimeters.

During the several days that the frogs were kept in captivity none was heard to utter a sound and all refused the camel crickets and earthworms which were offered. An examination of the stomach contents revealed that the six specimens had fed exclusively upon camel crickets. Aside from their larger size the females could be distinguished from the males only by the decreased amount of reddish-brown mottling on the

throat. Females were larger in all measurements, averaging 71.5mm. in snout-vent length, with the males averaging 64.6mm.

Only one interesting observation was made while the frogs were in captivity. After handling a specimen I rubbed my eye with a finger. Almost immediately a sharp stinging pain was felt which quickly increased in intensity. The eye became badly bloodshot and began to water within one minute. Discomfort continued for at least ten minutes. The eye soon cleared, however, and no later effects were noted.

I would like to acknowledge the assistance of Donald Donohoe and Carl O'Connor in the capture of specimens.

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AN INTERESTING FACTOR INFLUENCING *BUFO BOREAS* REPRODUCTION AT HIGH ELEVATIONS.—On July 14, 1954, on a fishing trip in the Wallowa Mountains, an unusual incident was observed which seems to constitute a rather unique natural danger to reproduction in *Bufo boreas* populations living at high elevations. While fishing in Sunshine Lake, a small lake about 200 feet in diameter located in Sec. 27, R. 44E., T. 4S. at an elevation of approximately 8,000 feet, I noticed four live *Bufo boreas* and one dead individual in passing completely around the lake's edge. A heavy snow pack formed a large sloping embankment along the entire western and southern shorelines. Shortly after I had passed over a portion of this bank of snow, a large piece, estimated to be about 45 feet by 9 feet and varying in depth up to six feet, broke off into the lake. The impact of the snow falling created a miniature tidal wave causing the lake to be swept over its confining banks on the opposite side where the live toads had been observed. The following day upon returning to the lake two masses of eggs lying 15 feet apart were found washed ashore, both being about three feet from the water's edge, apparently the result of the large waves. An examination of the eggs gave no evidence of their having begun development. It appears that this phenomenon of large chunks of ice and snow falling into lakes must be a common occurrence in this area, and may well be an important factor in determining the success or failure of *Bufo* reproduction.—Denzel E. Ferguson, Biology Dept., Eastern Oregon College of Education, La Grande, Ore.

TOLERANCES OF SOME WESTERN SNAKES TO COLD.—A recent article by Woodbury (1954, Herpetologica, Vol. 10, pp. 49-53), in which he discussed temperature in ectotherms, stimulated me to recheck some of my field notes. The notes were taken October 16, 1949, at the Tintic Snake Den which has been previously reported upon (Woodbury and Hansen, Herpetologica, Vol. 6, 1950, pp. 67-70).

During the afternoon and evening of October 15, 1949, it commenced to rain and during the night, it snowed. When I arrived at the Tintic snake den, at 8:00 a.m., October 16, there was six inches of snow covering the ground. The den had been previously fenced and two traps were placed in the fence to catch snakes returning to the den to hibernate. Thirty-two snakes were in the traps, consisting of 5 rattlesnakes, 25 striped racers, 1 gopher snake and 1 western king snake. Five newly born rattlesnakes were found under large rocks near the edge of the fence.

All of the striped racers were lying on the floor of the cages in a limp condition, showing no signs of life. The rattlesnakes in the cages were in a torpid condition but were able to move slowly. Even in this torpid condition, they could strike, although their movements appeared as if one was observing a slow motion movie. The gopher snake was extremely active and did not appear to be affected by the cold. The king snake was sluggish but more active than the rattlesnakes that were in the cages. The newly born rattlesnakes found beneath the rocks were active and did not appear to have been affected by the cold.

The snakes were collected in cages and brought into the laboratory. When I arrived some eight hours later at the University of Utah, 17 of the striped racers were active and 8 were dead. The other snakes were also active. The king snake had been frost-bitten in two places on the ventral side of the body and died 2 days later. All the other snakes continued to live and appeared to have not suffered damages from their exposure to the cold.

The aforementioned observations illustrate the fact that within ectothermic animals, the temperature and amount of exposure to cold does not affect all species of snakes to the same degree. It would appear from these observations that gopher snakes are least affected, then rattlesnakes, then king snakes, and striped races appear to be most effected by extreme exposure to cold. It was also clearly demonstrated that the behavior activities toward the avoidance of cold are extremely important during certain critical periods of the year. These examples raise many problems concerning the physiological tolerances of reptiles which might shed valuable information upon the field of herpetology.—Richard M. Hansen, Department of Vertebrate Zoology, University of Utah, Salt Like City, Utah.

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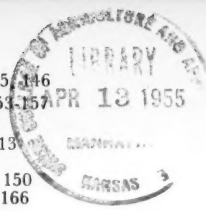

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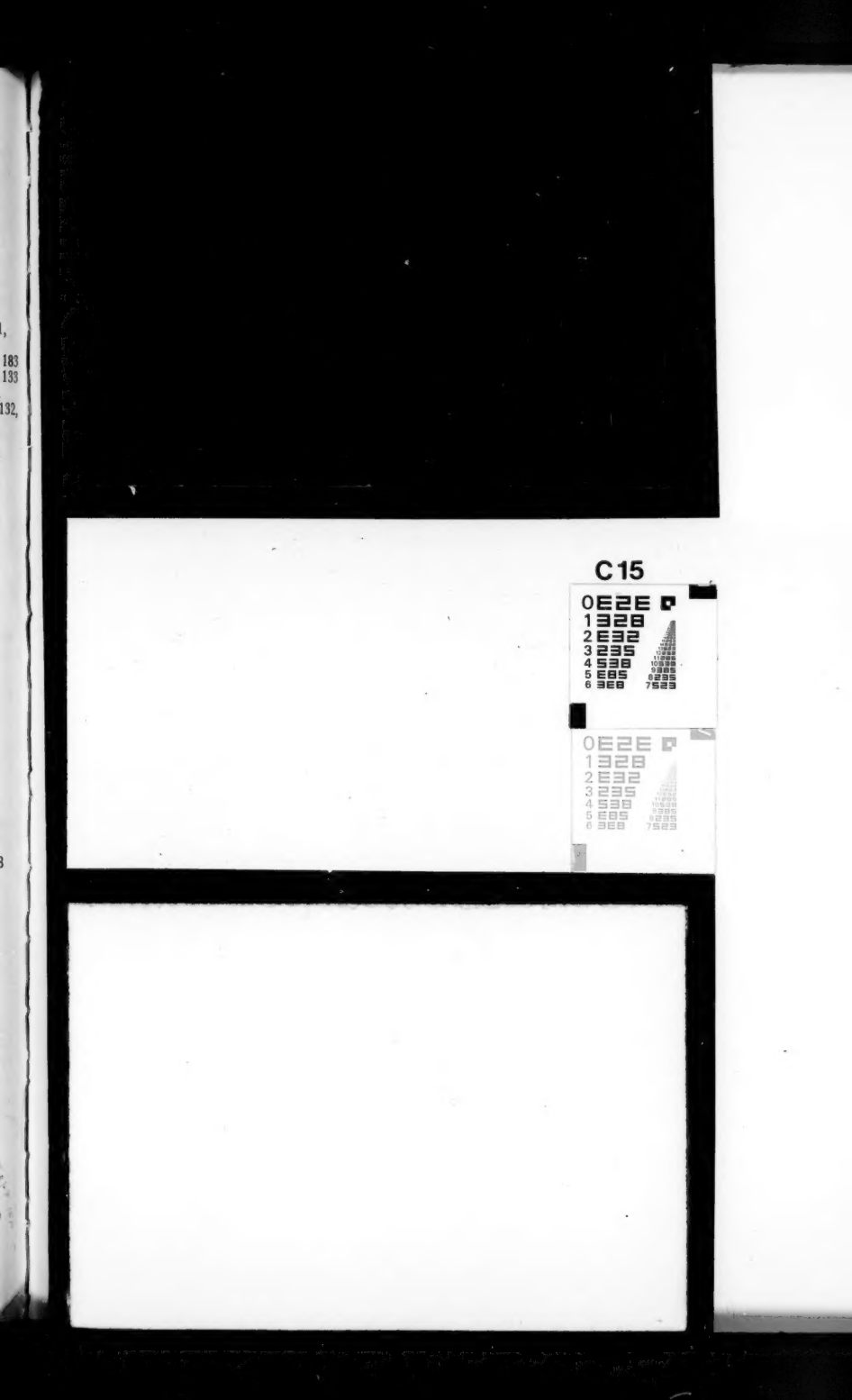
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